THE VASCULAR FLORA OF ST. BARBE SOUTH DISTRICT, NEWFOUNDLAND: AN INTERPRETATION BASED ON BIOPHYSIOGRAPHIC AREAS

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The Gulf of St. Lawrence region harbours a rich and diverse vascular flora which lacks study despite several previously published regional floras such as those of Scoggan (1950), Erskine (1960), Marie-Victorin and Rolland-Germain (1969), and Roland and Smith (1969). The flora of Newfoundland is known for the most part from the journals of Fernald (1911, 1926–27, & 1933) and the only complete checklist is that of Rouleau (1949, 1956). St. Barbe South occupies a large sector of the west coast of this province. The comprehensive study of its flora is an outgrowth of research on the vegetation and flora of the recently created Gros Morne National Park in the southern part of the District. This earlier research, carried out in conjunction with the park's natural resources analysis, began to reveal a complex and rich nordic flora (numbering some 780 vascular plant species), which warranted further study.

The objective of the work is to provide an analysis of the flora in essentially two parts. One section compiles, in the form of an annotated catalogue (Hay, 1976, Appendix II. 228 pp.), an exhaustive record of vascular plant collections with accompanying information describing their diverse habitats. The other section draws on the information contained in the catalogue to describe the region's flora in terms of biophysiographic units discernable within the study area. This latter approach is well suited to St. Barbe South because abrupt variation, particularly in bedrock geology and altitude, results in locally steep environmental gradients along which different elements of the flora are sorted out. The basic changes in landform, with resultant changes in microclimate, soils, drainage, etc., can be translated in terms of a scheme of physiographic units coupled with corresponding changes in the vegetation and flora. These integrated categories are described as biophysiographic areas. Limited by both a lack of floristic information and the complexity of factors controlling the manner in which elements of the flora are associated, an exhaustive analysis of each biophysiographic area was not attempted. Nevertheless, the general description for each unit attempts to highlight the significant associations in the flora of the study area.

METHODS

The inventory of herbarium collections from the study area dates from 1820 to 1974 (Hay, 1976, Appendix II). The annotations of earlier contributions to the flora are in large part unpublished information compiled by Professor E. Rouleau of the Université de Montréal. They are the fruit of his research on Newfoundland's flora in various North American and European herbaria as well as of his own field studies. The more recent collections, mainly made in the course of this study and related work on the vegetation and flora of Gros Morne National Park (Bouchard, 1974; Airphoto Analysis Associates, 1975; Bouchard & Hay, 1976a), substantiate most of the records of earlier botanists. Many of these later collections, made during the summers of 1972, 1973, and 1974, represent additions or extensions to the flora.

The sequence adopted for the taxonomic arrangement of families in the inventory (Hay, 1976) is taken from Rouleau (1970). Lower taxonomic units follow alphabetically. The latin nomenclature, with few exceptions, follows that of *Gray's Manual of Botany* (Fernald, 1950).

Generally, the level of precision sought in the taxonomic treatment has been limited to the rank of species. Occasionally, for reasons of interpretation in the text, subspecific taxa have been included. In difficult genera needing revision such as *Antennaria, Euphrasia,* etc., no attempt has been made to revise earlier collections (in many cases the only collections) even though their taxonomic status is dubious.

Each citation in the catalogue (Hay, 1976) includes the geographic provenance of the specimen followed by a habitat description, date, collector, collecting number and the abbreviation (in accordance with Holmgren & Keuken, 1974) of the herbarium where the specimen has been deposited. For example:

Lycopodium alpinum L.

Gros Morne: north slope of Gros Morne Mountain near summit with *Salix herbacea, Cassiope hypnoides, Phyllodoce caerulea.* 6/7/73. *Bouchard & Hay 73201* (CAN, MT). Long

Range Mts., Western Brook Pond: *Scirpus cespitosus*, *Carex oligosperma*, *Sphagnum* bog with numerous flashets and exposed boulders; on felsenmeer. 25/7/73. *Bouchard & Hay 73305* (CAN, MT).

For the most part, the collections are housed in the following herbaria: British Museum (Natural History), London (BM); National Herbarium of Canada, National Museums of Canada, Ottawa (CAN); Biosystematics Research Institute, Dept. of Agriculture, Ottawa (DAO); Gray Herbarium of Harvard University, Cambridge, Massachusetts (GH); Botanical Museum, University of Helsinki, Helsinki (H); Herbier Marie-Victorin, Institut Botanique, Université de Montréal, Montréal (MT); and the Agnes Marion Ayre Herbarium, Memorial University of Newfoundland, St. John's (NFLD). Although containing relatively fewer pertinent specimens, the following herbaria preserve additional historical contributions to the flora: Herbarium of the Royal Botanic Gardens, Kew (K); Botanical Museum, Oslo (O); and the Muséum National d'Histoire Naturelle, Laboratoire de Phanérogamie, Paris (P). A large number of additional herbaria which have received exchange specimens are also listed.

To present an overview of the vascular flora of the region, the study area was divided into a scheme of major biophysiographic areas. Although the choice of these categories was somewhat arbitrary, the units were selected to best reflect the manner in which different elements of the flora are associated. Much of the information used in the interpretation of the physiography and geology of St. Barbe South is taken from earlier research on the natural resources of Gros Morne National Park. Expeditions made in 1974, to northern areas in the District lying outside the national park, provided additional information concerning the major physiographic sites and related vegetation required to adequately describe the flora.

DESCRIPTION OF STUDY AREA

St. Barbe South District is situated on the west coast of Newfoundland where the Gulf of St. Lawrence narrows into the Strait of Belle Isle (Figure 1). The District, which covers an area of roughly 7,000 km.^{2}, lies between 49°30′ and 50°50′ north latitude, and between 56°40′ and 58°20′ west longitude (Figure 2). It is subdivided on the basis of altitude into two topographic land regions; a low-lying coastal plain, and an alpine plateau region.

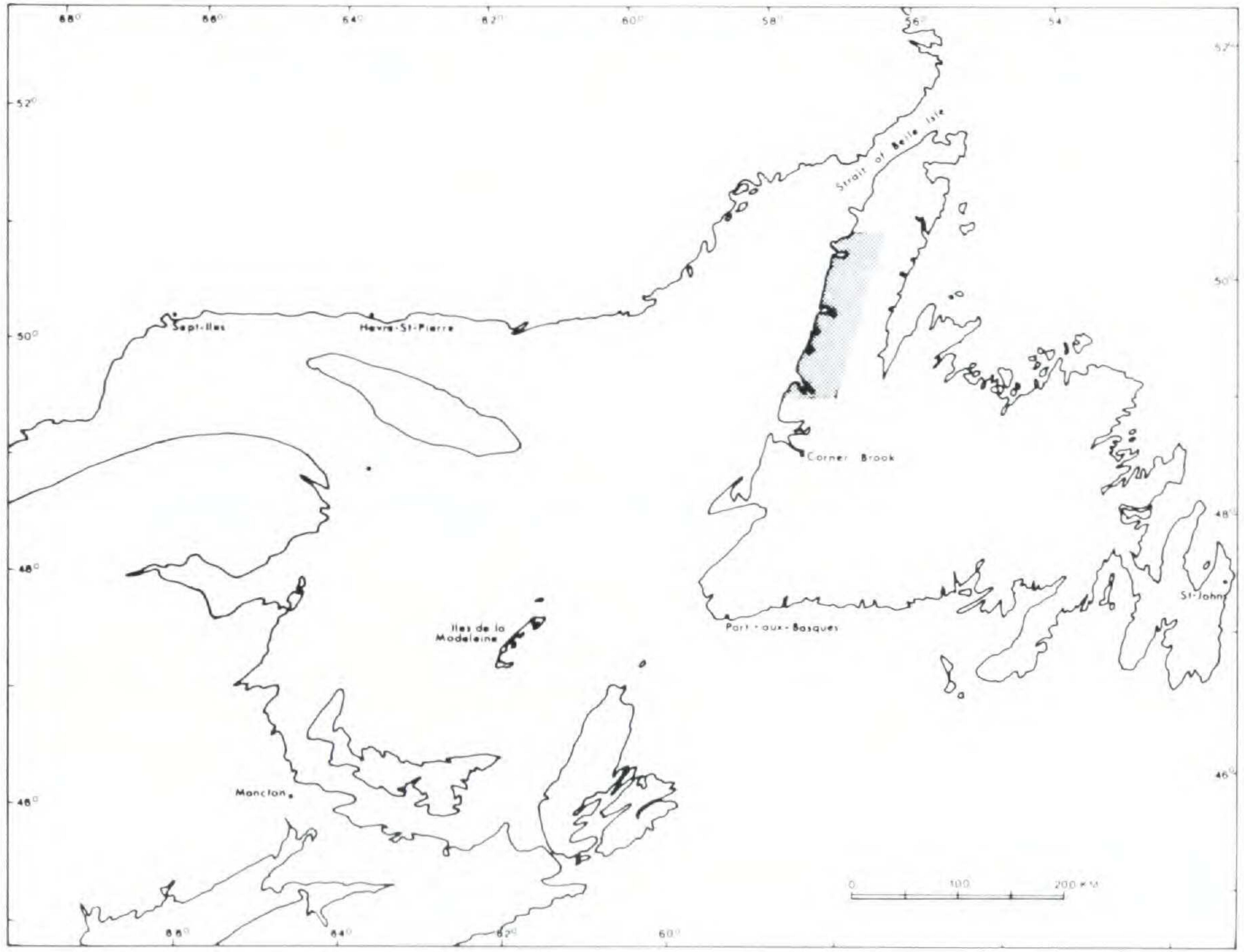

Figure 1. St. Barbe South District, Newfoundland, in the Gulf of St. Lawrence.

PHYSIOGRAPHY AND GEOGRAPHY

Coastal Plain. This gently rolling sedimentary plain, of up to 150 m. elevation, is bordered by the Gulf of St. Lawrence on its western side. The abrupt western scarp of the Long Range Mountains marks its interior eastern margin (Figure 2).

The coastal plain extends from Bonne Bay in the south, to the extreme north of the study area, a straight line distance of 175 km. Although it is reduced to a narrow coastal bench at both its northern and southern extremes, the width of the coastal lowland may stretch inland for up to 25 km. to the base of the Long Range Mountains. Numerous fjords, carved into the mountains, emerge onto the coastal plain creating large landlocked, freshwater forebays which drain into the Gulf. The basins of Bonne Bay and St. Pauls Inlet open directly into the sea and are partly saline. Abundant rivers, streams, lakes, ponds and bog pools constitute much of the surface area of the poorly drained, relatively flat coastal lowland.

Alpine Plateau. The high altitude land region, of 450 to 800 m. elevation, is an almost continuous plateau extending from Trout River Pond (Table Mountain) at the southern boundary of the study area, to the South Summit of the Highlands of St. John at the extreme north. Its eastern boundary is the plunging western escarpment of the Long Range Mountains, the axis of which roughly parallels the coastline. The eastern boundary of St. Barbe South marks the western limit of the alpine region in the study area.

The alpine plateau is a relatively flat, rugged peneplain surface (Oxley, 1953). It is a part of the Long Range Mountain complex which forms the backbone of the Northern Peninsula. The precipitous western escarpment is breached by numerous spectacular glacier-carved canyons and previously mentioned fjords.

The rolling surface of the plateau, which for the most part is gradually inclined to the east, retains abundant freshwater lakes and ponds. The watershed, draining to the west, discharges onto the coastal lowland, whereas east-flowing drainage is discharged by such numerous rivers as the Humber, Main and Soufflets Rivers.

GEOLOGY

Coastal Plain. The southern sector of the coastal lowland, between Bakers Brook and Daniels Harbour, is composed mainly of three groups of interbedded sedimentary formations, the Humber Arm Group, the Green Point-St. Pauls Group and the St. George Group which alternate in bands parallel to the coast (Geologic map; Baird, 1958). Except for some breccia of Middle Cambrian, and some Pennsylvanian and/or Mississippian sedimentaries, these groups are Ordovician.

The Humber Arm Group is found throughout this southern area. It is composed mainly of sandstones, conglomerates, and grey shales (Baird, 1958). It alternates with the Green Point-St. Pauls Group, composed of thin bedded limestone, abundant Cow Head type breccia, shale and siltstones. The St. George Group, composed of massive limestones, dolomites and interbedded shales, constitutes an important part of the bedrock which forms the low rolling piedmont area along the front flank of the Long Range. Some exceptional exposures of this group form the high stratified cliffs along the southern shore of the East Arm of Bonne Bay (Airphoto Analysis Associates, 1975) south of the coastal plain. The limestone breccia is most abundant at Broom Point and Cow Head.

With the exception of the St. George Group, these Ordovician sedimentary rocks do not represent the original, in situ deposits of the coastal plain. They are part of a complex alternating sequence of tilted thrust sheets which have overridden the original lowland deposits. This sequence is the result of a deformation of the interbedded formations during transport (allochtonous klippen) from their original site of deposition to the east of the Northern Peninsula (Airphoto Analysis Associates, 1975; Cumming, 1973; Fleming, 1973).

The northern sector of the coastal lowland, from Daniels Harbour to Eddies Cove West, is composed of the original, undeformed, sedimentary deposits which were laid in place (autochtonous) while the Northern Peninsula was part of the submerged continental shelf of eastern North America (Fleming, 1973). These marine deposits consist of Lower Cambrian to Middle Ordovician carbonates; mainly St. George dolomite and Table Head limestone, with some shale and interbedded limestone, dolomite and slate of Labrador Group sediments. They are best exposed at Bellburns (Table Point and Bateau Barrens), the Pointe Riche Peninsula, and the vertical cliffs forming the western face of Doctor Hill (the South Summit of the Highlands of St. John).

Except for a few protruding rock ridges, exposed coastal headlands, and occasional uplifted cliffs along the Long Range escarpment, the sedimentary rocks of the coastal lowland are generally buried beneath organic, marine, glacial, waterlaid and eolian deposits. This complex array of surficial deposits is easier to understand when interpreted in terms of a piedmont glacier phase characterized by expanded-foot valley glaciers which formerly terminated in a sea that stood about 100 m. higher than present-day sea level, and which transgressed inland to that elevation as the glaciers receded up the troughs of the Long Range Mountains (Grant, 1969b, 1972a, 1973a).

Alpine Plateau. The predominant geological formation of this alpine area is the Precambrian Long Range plateau, an uplifted block of Grenville basement rock. These rocks, which are so extensively exposed at the margin of the Canadian Shield, consist principally of metamorphic and igneous granite or granite gneiss (Cumming, 1973).

Also in this land region are several geologically distinct alpine summits situated as outliers against the western escarpment of the Precambrian massif. They are uplifted monadnocks of Lower Cambrian Labrador Group sediments (Cumming, 1973) which were formerly part of the coastal lowland. These exposures of interbedded limestone, dolomite slate and quartzite were thrust upward along the major tectonic fault which separated the coastal lowland and the alpine Long Range. Gros Morne, Killdevil, Blue Mountain and Doctor Hill form these alpine summits and are protected by caps of more resistant quartzite.

In the southwestern sector of the study area, the broad summits of Table Mountain, Lookout Mountain, and the northern portion of the Gregory Plateau also form a major outlying highland area of the alpine land region. These mountains are a confluence of various geological formations that have been laterally transported (klippen), due to tectonic movement, from their site of origin. They represent the northern portion of the Bay of Islands Igneous Complex, comprised mainly of ultramafic serpentine, altered gabbroic rocks and quartz diorite (Smith, 1958). In particular, the denuded serpentine tableland of Table Mountain forms an impressive uplifted, deeply dissected peneplain bounded by steep cliffs.

The extensive summit area of much of the alpine region is characterized by scoured bedrock surfaces with surficial deposits of glacial drift, erratic boulders and colluvial material as a result of Pleistocene glaciation. Local accumulations of felsenmeer on some of the higher summits are interpreted by Grant (1969b, 1973a) as being partly relict from a nunatak phase of valley deglaciation and partly due to permafrost effects of present climate.

CLIMATE

Newfoundland's climate is known primarily from the work of Hare (1952). In the west coast sector, the maritime and northern geographic situation, and the great variation in altitude between the coastal lowland and the alpine plateau, result in important regional climatic differences. The following factors have an important influence on the vegetation and flora of the study area: a cool climate with a short growing season, a moderating influence of the ocean, a continual moisture excess, and the strong prevailing winds.

The cool climate and short growing season are responsible for the predominantly boreal aspect of the vegetation. The mean air temperature (mean of daily maximum and minimum) in July ranges from 15.6°C in the south to 10°C in the north (Hare, 1952). In January, this range is from -6.7°C to -12.2°C. A striking feature of the winter temperatures is that, due to the warming maritime influence on the coast, the -9.4°C isotherm for mean air temperature lies along the boundary between the coastal plain and the Long Range Mountains. The coastal plain has a cooler summer than the interior of the Island of Newfoundland due to the moderating effect of the Labrador Current. Sea surface temperatures vary between 10°C and 12.8°C in July.

The vegetative growing season ranges from 120 to 150 days (Hare, 1952), the lag being particularly pronounced in the northern sector of the Long Range. The start of the vegetative season, when mean air temperature passes 6.1°C, is between May 20 and May 25 in the southern part of the study area. In the northern Long Range sector, a possible late starting date of June 5 is more than 50 days

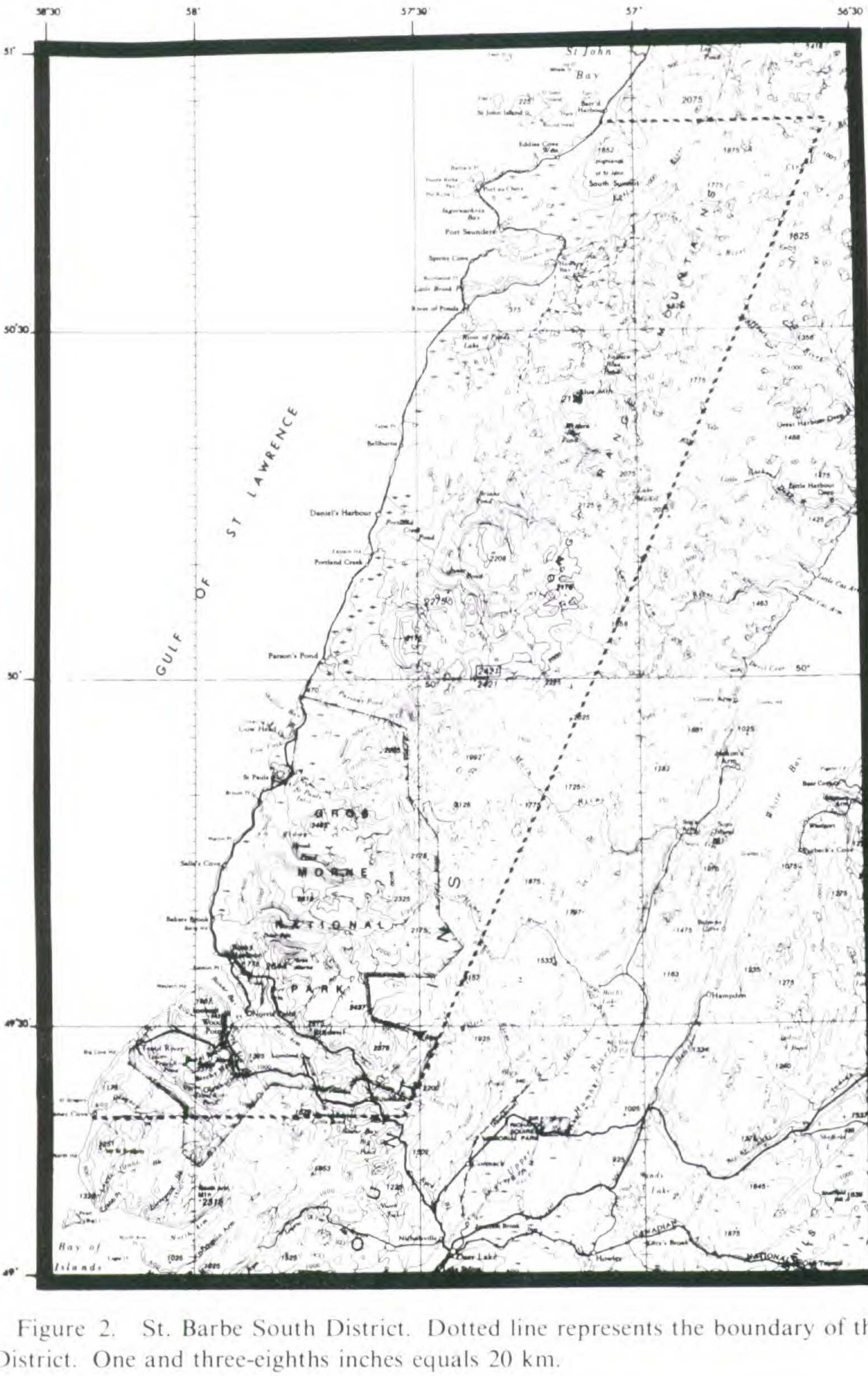

Figure 2. St. Barbe South District. Dotted line represents the boundary of the District. One and three-eighths inches equals 20 km.

behind the corresponding period for Montreal and Ottawa. The extreme contrast results from the constant presence on both sides of the northern half of the Northern Peninsula of Labrador Current water which is often ice-laden well into July. The higher summit areas in the more southern sector of the alpine plateau region probably have a similarly tardy vegetative season.

Relatively high precipitation, low potential evapotranspiration, and poor water drainage due to the general flatness of both the coastal lowland and the alpine plateau region have resulted in the formation of extensive peatland. The mean annual precipitation is between 89 and 114 cm. (Hare, 1952). The potential evapotranspiration, or the "landscape water need", varies from 31 cm. in the north to 48 cm. in the south, leaving an annual moisture surplus greater than 40 cm. The mean annual snowfall ranges from 250 to 380 cm.

The predominant southwest onshore winds are an important environmental factor responsible for the structure of several plant communities, especially the coastal krummholz and upland tuckamoor.

VASCULAR FLORA OF THE REGION

HISTORY OF FLORISTIC STUDIES

The history of botanical exploration of this part of the west coast of Newfoundland dates from the early part of the nineteenth century. However, the inaccessibility of the Island, and even more so of the Northern Peninsula, has greatly hindered studies of the little known flora of this region.

The earliest records concerning the flora appeared in the journal of the French naturalist, Bachelot de la Pylaie, who briefly explored the region of Port au Choix and Ingornachoix Bay in 1820 (Leroy, 1957). Most of his observations concerned cryptogamic species and only the algae section of his *Flore de Terre-Neuve et des Iles Saint-Pierre et Miquelon* was published (Fernald, 1911). Nevertheless, specimens of his vascular plant collection have been preserved at the Muséum National d'Histoire Naturelle de Paris.

The nineteenth century epoch of botanical explorations also includes meagre collections of several amateur botanists. James Richardson explored this west coast area for the Geological Survey of Canada in 1861, and concomitantly made vascular plant collections for the National Museum of Canada. In 1873, an extensive list of flowering plants and ferns was compiled by H. Reeks, a naturalist who convalesced for some time at Cow Head (Robinson & von Schrenk, 1896). The herbarium collections of the "Arethusa Expedition" to the Pointe Riche Peninsula, led by Bartlett and Budingham in 1885, are preserved at Harvard University. Finally, late in the century, the Rev. A. C. Waghorne published a partial flora of Newfoundland (Waghorne, 1893, 1895, 1898), compiled with the assistance of the Dominion botanist, J. Macoun. Waghorne's catalogue was never completed. The little collecting he did in St. Barbe South was restricted to Chimney Cove.

This rather meagre record of botanical studies prompted Professor M. L. Fernald of Harvard University to write that, "in spite of notes already published, the flora of Newfoundland as a whole has been among the least known of any flora in civilized America" (Fernald, 1911). He consequently led a series of expeditions to Newfoundland to fill a void in the botanical knowledge of the territory about the Gulf of St. Lawrence.

On the first expedition of 1910, two members, Professor K. M. Wiegand and J. Kittredge, spent only a few days collecting specimens from three localities in St. Barbe South. Some of their more interesting discoveries on the limestones of Cow Head and Ingornachoix Bay included *Arabis alpina, Botrychium lunaria, Cochlearia cyclocarpa* (type), *Dryas integrifolia, Gentiana nesophila, Hedysarum alpinum, Lesquerella purshii, Salix reticulata, Saxifraga cespitosa* and *Tanacetum huronense.* At Bonne Bay, the serpentine tableland (Table Mountain) and Lookout Mountain yielded interesting mentions for the flora in *Adiantum pedatum* var. *aleuticum, Arenaria humifusa, Armeria maritima, Lychnis alpina, Potamogeton oakesianus* and *Schizaea pusilla.*

Wiegand and Kittredge's collections of 1910 from Pointe Riche and "l'avant-goût" of a brief stopover at Port Saunders in 1924 prompted a return voyage in 1925. The expedition mainly botanized Bard Harbour Hill (the North Summit of the Highlands of St. John) and St. John Island which lie adjacent to, but outside the northern limit of, St. Barbe South. Fernald profited by an afternoon trip to the calcareous talus of the western escarpment of Doctor Hill (the South Summit of the Highlands of St. John) to collect such rareties as *Gentiana propinqua, Polystichum lonchitis, Senecio pauciflorus* and the endemic *Epilobium scalare* (type).

Fernald's 1929 expedition included botanists B. Long and J. M. Fogg. They spent two weeks exploring the limestone barrens of the Pointe Riche Peninsula collecting such "discriminatingly selected specialties" (Fernald, 1933) as the taxonomically complex *Antennaria, Arnica, Salix* and *Taraxacum,* which abound there. An excursion to the southern slopes of Doctor Hill led to the discovery of such rare species for the study area as *Athyrium alpestre, Phyllodoce caerulea, Salix herbacea, Streptopus* × *oreopolus, Vaccinium* × *nubigenum* and *Viola palustris* even though Fernald (1933) qualified the botanical status of the siliceous tableland as "a poor place when contrasted with Bard Harbour Hill and the calcareous western slope of Doctor Hill at John Kanes Ladder." The final leg of this voyage was spent at Bonne Bay, where for three weeks the group continued to display their uncanny knack for ferreting out many rare and interesting species enumerated in Fernald's journal (1933). Their itinerary included such outstanding physiographic features as the limestone cliffs and coves of East Arm, the serpentine Table Mountain, Lookout Mountain, Killdevil Mountain and the barachois of the Lomond River.

Fernald's voyages culminated in the most completely documented study of the vascular flora of Newfoundland (Fernald, 1911, 1918a, 1918b, 1924, 1925, 1926–27, 1930, 1933). His ensuing theories concerning the phytogeographic distribution of different elements of the flora as well as his highly readable journals did much to stimulate further study. The calcareous exposures of Bonne Bay and the adjacent serpentine of Table Mountain subsequently attracted such botanists as Kimball, 1919; Bishop, 1928; Simpson, 1928; Jansson, 1930; Rishbeth, 1937; and Penson, 1941. The limestone barrens at Pointe Riche were explored by Abbe and Pease, 1931; Ayre, 1936; and Penson, 1941. These expeditions added little or no published information on the flora of the region.

In 1948, Professor E. Rouleau of the Université de Montréal began serious botanizing of the entire province over a period of time that would span twenty years. His painstaking compilation of previous collection records and of distribution maps, as well as his considerable contribution of collected material represents the second major phase in the development of a comprehensive view of the flora of St. Barbe South. Part of this information was published as a checklist of the vascular plants of Newfoundland (Rouleau, 1949, 1956).

The inventory of the flora continued to grow with additions by Professor R. Tuomikoski, 1949, from the University of Helsinki, Finland, and by Elkington, 1958, of the British Museum. Expeditions from the Canada Department of Agriculture, Ottawa, to the west coast of Newfoundland resulted in collections by Basset, 1949; Savile, 1951; and Donly, 1955, from numerous localities in the study area.

In more recent years, ecological studies in the region have served to increase our knowledge of the flora. The description by Rowe (1959) of boreal forest sections which dissect the study area, and a subsequent more detailed vegetation analysis by Damman (1967) were the first steps toward an understanding of possible environmental factors responsible for the presence of certain elements of the flora and the manner in which they are associated.

The recent creation of Gros Morne National Park in the southern part of St. Barbe South gave rise to the third major phase in the study of the flora. In 1972, a vegetation study of the coastal plain area of the park (Bouchard, 1974) was the first comprehensive analysis of all the vascular flora within a circumscribed sector of the study area. The floristic part of a later report (Bouchard & Hay, 1976a) presents integrated data concerning frequency of occurrence, manner of association and habitats for all the coastal plain vascular plants. Rouleau *et al.* (1975) published an exhaustive checklist of the vascular flora of the entire park. This was followed by a complete biophysical resource inventory by Airphoto Analysis Associates (1975). The latter report incorporates useful information concerning the floristic composition and the environmental controls of many vegetation associations.

GEOGRAPHIC AFFINITIES

Newfoundland lies entirely within the Boreal Forest Region of Canada (Rowe, 1959) and includes large areas of forest-tundra, a subsection of this region grading into the arctic tundra. Overall, the flora of St. Barbe South is characterized by the core of species which typify, or are associated with, the essentially transcontinental boreal forest vegetation. While the dominant tree species vary, *Abies balsamea, Betula papyrifera, Picea glauca* and *P. mariana* are all characteristically present. Due to regional differences in the physiognomy of the vegetation, and in the flora, this sector of the west coast embraces three boreal forest subsections (Rowe, 1959). Thus, the Corner Brook Section, encompassing the area south of Bonne Bay, is distinguished because of more demanding southern species such as *Betula alleghaniensis* and *Fraxinus nigra*. The Northern Peninsula Section includes the flanks and piedmont area of the Long Range Mountains as well as the coastal plain. The Newfoundland-Labrador Section, which includes the Precambrian alpine plateau, is part of Rowe's broader forest-tundra section.

The flora of the west coast sector of Newfoundland has long attracted the attention of phytogeographers because of the high proportion of vascular plants which are not typical of the boreal forest flora. Some of these species show varying degrees of disjunction with their main centres of geographic distribution, while others are endemic to the Gulf of St. Lawrence region. Rowe (1966), following the individualistic concept of plant association of Gleason (1939), summarized the difficulty in defining sharp boundaries for floristic and vegetation zones stating "every species while sharing area with others, has its unique pattern of prominence and distribution." As an alternative, Rousseau (1974) identified eleven major phytogeographic groups in the flora of Quebec-Labrador. Similarly, the flora of St. Barbe South, although confined to a much smaller area, contains elements representative of nearly all of these chorologic groups.

Cosmopolitan Element. Species of wide ecological amplitude (often colonizing open habitats) such as *Cystopteris fragilis*, *Deschampsia flexuosa* and *Equisetum arvense* are examples of this group with a world wide distribution.

Circumpolar Element — Northern Hemisphere. This element of the flora consists primarily of two groups: (1) circumpolar boreal forest species such as *Circaea alpina*, *Moneses uniflora* and *Pyrola minor;* and (2) arctic-alpine species of arctic circumpolar distribution with southern extensions of range in suitable, usually alpine, habitats. Within the latter group, the tundra barrens of the Long Range Mountains yield numerous examples such as *Arctostaphylos alpina*, *Loiseleuria procumbens* and *Lycopodium alpinum* (Bouchard & Hay, 1974). Several examples such as *Dryopteris limbosperma* (syn. *Thelypteris limbosperma*, Bouchard & Hay, 1976b; syn. *Oreopteris limbosperma*, Bouchard, et al., 1977) show

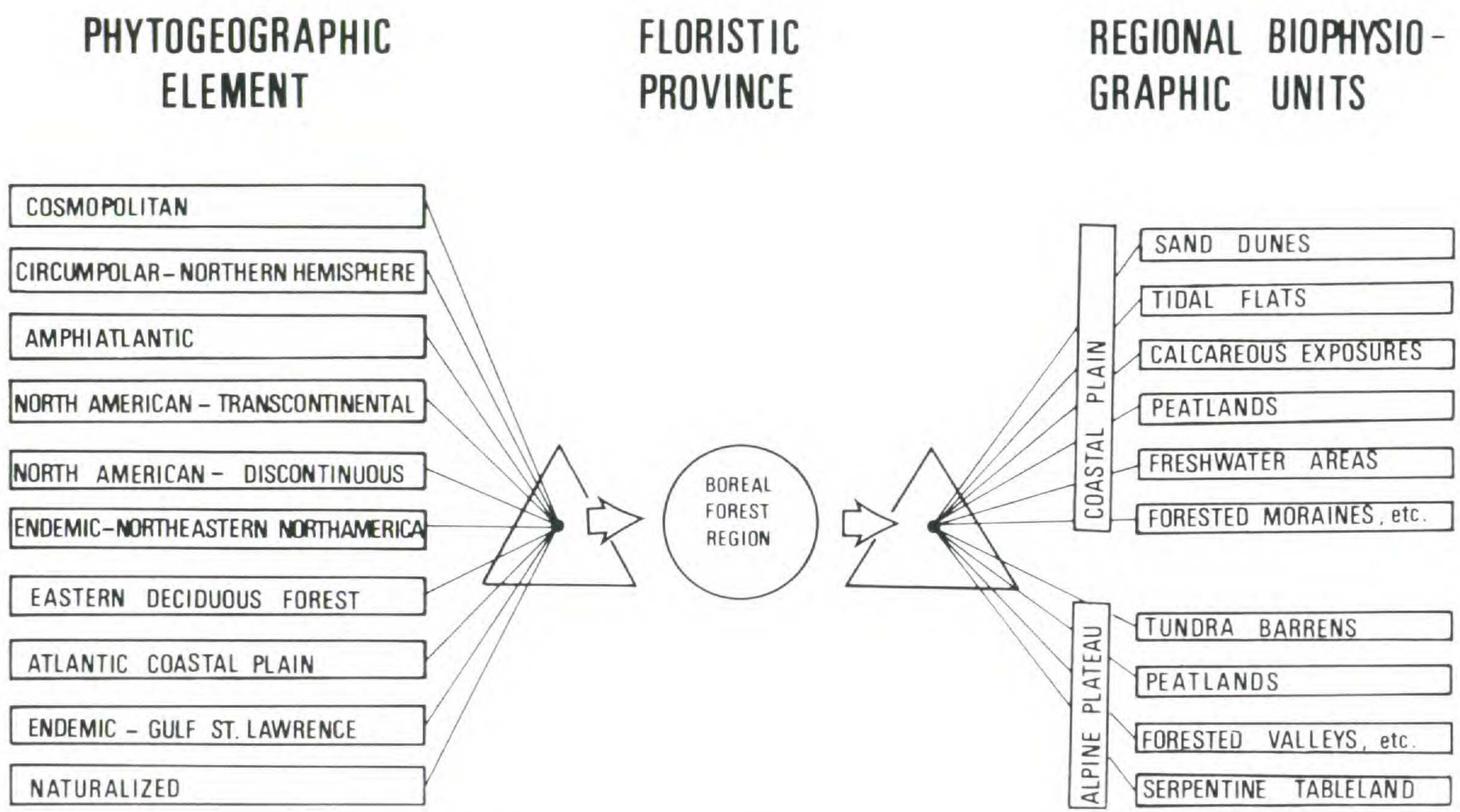

Figure 3. "Refraction" of the flora of St. Barbe South due to a prism-like influence of environmental, historic and biotic controls.

a highly disjunct distribution in the North American part of their range. Other species such as *Androsace septentrionalis, Potentilla nivea* and *Woodsia alpina* have extended their range into the Gulf of St. Lawrence region on barren alkaline soils such as occur on the calcareous coastal plain exposures. Additional representative species including *Lycopodium selago* and *Silene acaulis* are found on limestone, granite and serpentine barrens throughout the study area.

Amphiatlantic Element. This flora, with a macrodistribution pattern ranging mainly along both sides of the Atlantic, includes *Armeria maritima, Diapensia lapponica, Salicornia europaea, Saxifraga paniculata* and *Viola palustris.* These plants are found mainly in restricted habitats of the study area such as the tidal flats, tundra barrens and calcareous barrens.

North American Element-Transcontinental at Canadian Latitudes. Two major groups comprise this element: (1) boreal forest species such as *Abies balsamea, Cornus canadensis, Gaultheria hispidula, Kalmia poliifolia* and *Picea glauca* which characterize the forested landforms of the study area; and (2) several arctic-alpine species including *Dryas integrifolia, Rubus acaulis* and *Vaccinium cespitosum* colonizing coastal limestone barrens or alpine tundra. Rousseau also distinguished a "quasi-transcontinental" group with similar North American distribution including *Aster puniceus, Cypripedium acaule* and *Potentilla tridentata.*

North American Element-Discontinuous in Continental Interior. Plants of this group, which includes *Orobanche uniflora* (including *O. terrae-novae*), *Parnassia parviflora* and *Viola pallens* from the study area, show discontinuity, often in the midwest of their continental distribution.

Endemic Element in Northeastern North America. Several species typical of peatland flora such as *Andromeda glaucophylla, Carex exilis, Sarracenia purpurea* and *Vaccinium angustifolium* show this more restricted regional distribution pattern. *Lycopodium sabinifolium* and *Salix uva-ursi* are arctic-alpine examples of this group.

Eastern Deciduous Forest Element. Although several species representative of this element extend their range further north in the study area (e.g. *Vaccinium macrocarpon*), tree species such as *Acer rubrum, Betula alleghaniensis* and *Fraxinus nigra* appear to be at or near their northern limit at Bonne Bay and are rare and restricted to forested slopes at this locality.

Atlantic Coastal Plain Element. This distribution pattern is represented mainly by distinctive plants which have been only rarely recorded from the alpine peatlands of the plateau region south of Bonne Bay. They include *Bartonia paniculata, Habenaria blephariglottis, Potamogeton oakesianus* and *Schizaea pusilla.*

Endemic Element. Species of this group have been mainly described by Fernald (1911, 1926–27, 1933, 1950) and many are of questionable taxonomic status. Several are endemic essentially to the Gulf of St. Lawrence centred-region and include *Arnica chionopappa, Lesquerella purshii, Oxytropis johannensis, Streptopus* × *oreopolus, Taraxacum ambigens, Triglochin* × *gaspense* and *Vaccinium* × *nubigenum.* Other such species are more narrowly endemic to the study area and include *Antennaria bayardii, A. columnaris, Epilobium scalare* and *Salix wiegandii.* The majority of these species are found on the calcareous exposures of the coastal plain. Many await revision and are probably only edaphic ecotypes of closely related species.

Naturalized Element. These species, introduced mainly from Eurasia, include *Aconitum bicolor, Agropyron repens, Plantago major, Ranunculus acris, Rumex crispus, Trifolium repens* and *Tussilago farfara.* They are relatively few and favour habitats of the coastal plain which have been disturbed due to road construction, settlement, logging and livestock grazing.

In conclusion, there has been much discussion in response to the phytogeographic questions raised by the existence, particularly in the Gulf of St. Lawrence region, of the many vascular plants which are apparently endemic or which have geographic affinity with floristic elements other than the core of species that characterize the general boreal forest region. The merging together of distinct floristic elements around the Gulf has been described in Nova Scotia (Roland & Smith, 1969), in Newfoundland (Fernald, 1911, 1925, 1933; Damman, 1965), and in Quebec (Marie-Victorin, 1938). Theories proposed to account for these diverse elements in the flora range from survival in the wake of Pleistocene glaciation in alpine or coastal refugia (Fernald, 1925; Drury, 1969; Wynne-Edwards, 1937, 1939), to the importance of opportunities for migration (long distance dispersal), competition and disturbances such as fire (Rowe, 1966). Rousseau (1974) brought these many hypotheses into perspective, discussing in detail their importance in relation to his phytogeographic groups for the flora of Quebec-Labrador. He summarized, "en plus des facteurs climatiques qui influencent manifestement la répartition des plantes, il en existe d'autres tels la composition du sol, les éléments biotiques (constitution génétique et concurrence avec d'autres plantes) ainsi que les éléments historiques (glaciation et submersion postglaciaire), lesquels modifient grandement certaines modalités de distribution qui autrement devraient être plutôt réguliéres."

The interplay of environmental (especially climate), historical and biotic factors responsible for the presence of different phytogeographic elements in the flora, and the manner in which they are associated, can be visualized in terms of a model (Figure 3). These factors have permitted the segregation of some plants from their affiliated geographic groups and integrated them into an essentially boreal forest flora. These same factors, particularly with the locally steep environmental gradients, have had a "prismatic" effect on the different elements of the flora causing their "refraction" into different plant communities colonizing diverse physiographic units of the study area.

BIOPHYSIOGRAPHIC AREAS

Coastal Plain, Sand Dunes.

PHYSIOGRAPHY. The coastal sand dunes of St. Barbe South (Figure 5A) are a conspicuous landform of the coastal plain due to their elevation above the surrounding lowland. They are beach dunes, as defined by Way (1973), of a smaller scale than examples occurring elsewhere in the Gulf of St. Lawrence such as les Iles-de-la-Madeleine (Grandtner, 1967).

Sufficient sand required for dune formation occurs infrequently on the sedimentary coastal terrain. However, large surficial deposits have accumulated at the mouth of several rivers which drain the Long Range Mountains and the coastal plain. The source of sand appears to be the Precambrian granite of the Long Range. In each case, the river-transported sand is discharged into a bay which opens directly on the sea and which is bounded immediately to the north by a retaining rocky peninsula. The rock promontory arrests the littoral drift of the sand and the ensuing dune formation occurs behind the bay-shore according to the processes outlined by McHarg (1969) and Way (1973).

The dunes form behind the brackish sandy seashore (vegetation described in the following section on Tidal Flats). They form two distinct zones which have characteristic vegetation: (1) the hummocky foredunes or primary dunes of recent deposition which are exposed to salt spray and sand movement, and which are continually being broken and reformed by onshore winds; and (2) the higher fixed dunes which are normally stable and colonized by scrub vegetation.

VEGETATION AND FLORA.

Foredunes. The unstable foredune area is colonized almost exclusively by *Ammophila breviligulata* and to a lesser extent by *Elymus arenarius.* The plant cover for this zone is well below 50% (Bouchard, 1974). Frequent blow-outs occur where the stabilizing marram-grass or beach-grass cover has been disturbed. Once the foredunes have been secured, other psammophytes or halophytic species such as *Carex maritima, Gentiana amarella, Juncus balticus, Lathyrus japonicus, Plantago juncoides, Rumex pallidus, Senecio pseudo-arnica* and *Smilacina stellata* may become established. *Ammophila breviligulata* is the only species which grows uniquely on this landform. The others (*Carex maritima, Gentiana amarella,* etc.) are found occasionally in other physiographic sites such as the tidal flats and the sea cliffs.

Numerous opportunistic, turf-forming grasses such as *Agrostis alba, Festuca rubra, Poa palustris* and *Poa pratense* may consolidate local areas in the foredune zone. Other species which are also found in this protective turf include *Equisetum arvense, Potentilla anserina, Trifolium repens* and *Sagina nodosa.* Weedy species such as *Anaphalis margaritacea, Senecio vulgaris, Ranunculus repens* and *Rhinanthus crista-galli* also become established as scattered individuals in this herbaceous community.

Fixed Dunes. The higher fixed dunes are usually stabilized by a scrub formation of *Abies balsamea* and *Picea glauca.* This vegetation is often destroyed by sand movement or sand blasting where the front-lying dunes have been disturbed. Other species commonly found in this scrub thicket, especially on the exposed front face of the dune, are *Alnus crispa, Cornus alba, Juniperus communis, Ribes lacustre* and *Shepherdia canadensis.*

This vegetation unit grades into the balsam fir scrub or forest communities (Bouchard, 1974) which dominate the well drained areas of the coastal plain. This front-lying scrub is consequently composed mostly of species coming from this latter vegetation type.

GEOGRAPHIC DISTRIBUTION. The essential physiographic conditions leading to the formation of major sand dunes have occurred at three localities along the coast. At the mouth of Western Brook, the sand dune system has been built up in the bay bounded on the north by Broom Point. The dunes which surround Shallow Bay at the mouth of the Stanford River have accumulated between the peninsula of Lower Head and the village of Cow Head. They are the largest example of this landform in the region. The Portland Creek sand dunes have been retained in Portland Cove which abuts on Eastern Head peninsula. Other surficial deposits of sand in the interior of the coastal plain are very local and have been covered by fir scrub or forest vegetation.

Coastal Plain, Tidal Flats and Brackish Shores.

PHYSIOGRAPHY. In comparison with the salt marshes which rim the shores of the Atlantic provinces such as Nova Scotia (Harvey, 1973), the tidal flat marshes (Figure 5B) of St. Barbe South District are neither extensive nor well developed. They nevertheless conform to the general concept in that they originate as coastal sand or mud flats which are subject to periodic inundation by the tide. These flats are colonized by a characteristic halophytic vegetation which may lead to the development of a closed marsh community. The brackish soil water and/or tidal submergence are clearly the chief factors controlling the formation.

Shallow bays and river estuaries which are protected from the heavy wave erosion of the open coast permit gradual siltation leading to the formation of tidal flats and brackish shores.

VEGETATION AND FLORA. In this biophysiographic unit, three general vegetation units can be described; (1) the open tidal mud flats which are partially colonized by turfy herbaceous communities, (2) the upper salt marsh rimming the lower tidal flats, and (3) the vegetation of the brackish sand or gravel shores which do not necessarily form a part of the tidal flats.

Tidal Mud Flats. The zonation of the vegetation on the lower tidal flats depends on the depth and duration of inundation by the

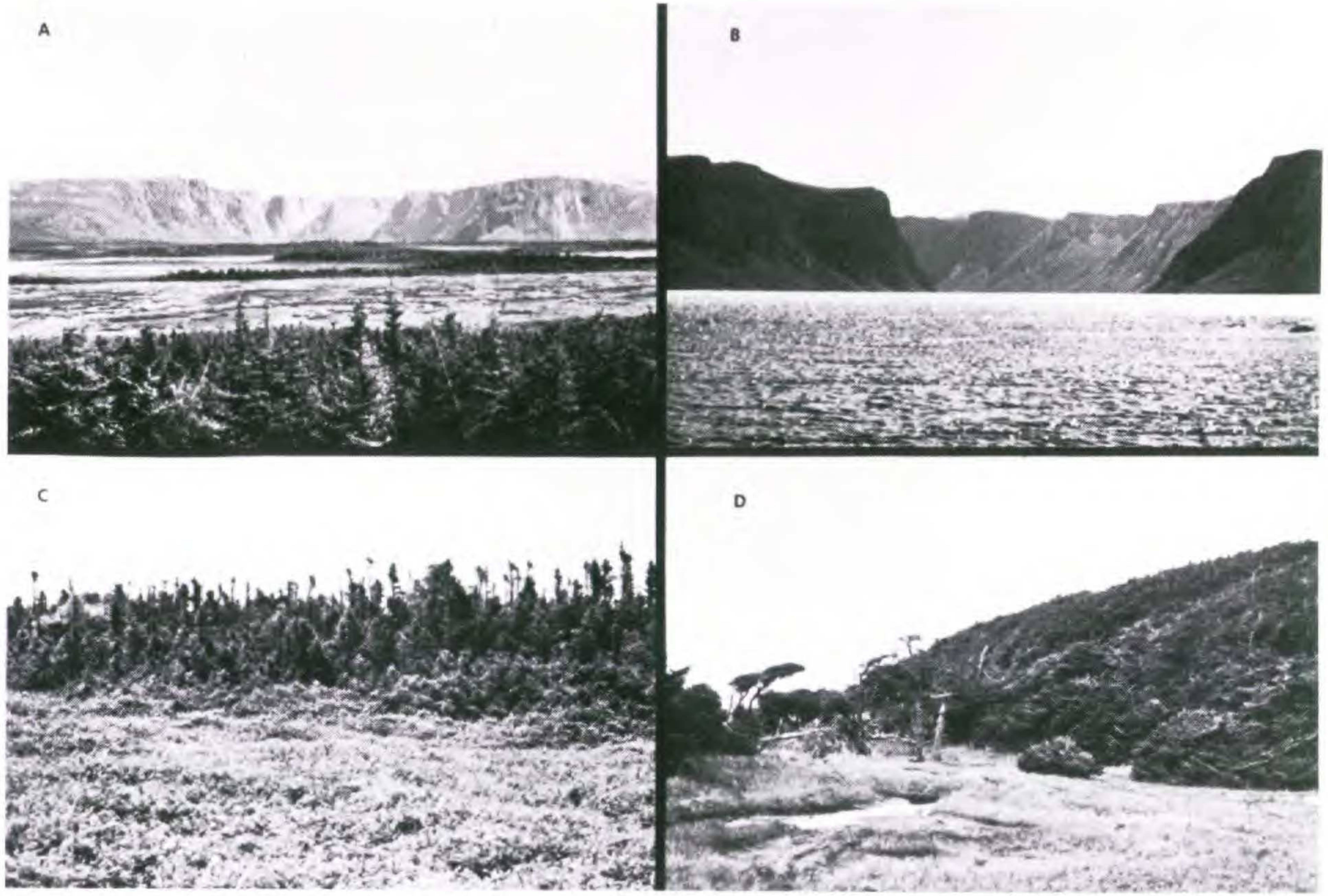

Figure 4. A, Western Brook Pond "fjord" and the coastal plain. B, A view of Western Brook Pond from the coastal plain. C, Dwarf black spruce scrub in the foreground; black spruce scrub in the background. D, Coastal krummholz of wind-shaped balsam fir and white spruce scrub.

tides and is well developed only where the change in elevation is very gradual. In the seaward sector, which is normally submerged by salt water, a single vascular plant *Zostera marina* is found growing with abundant marine algae. The more elevated open mud flats, which are flooded to shallow depths with each tidal cycle, are virtually bare of vegetation except for *Salicornia europaea* which may form extensive monospecific populations in which the plant cover is probably less than 10% (Bouchard, 1974). However, towards their upper extreme, these mud flats are covered by a turfy herbaceous community dominated by *Eleocharis halophila, Festuca rubra, Plantago oliganthos, Ranunculus cymbalaria, Salicornia europaea, Scirpus rufus* and *Triglochin palustre.* Some other characteristic species include *Eleocharis parvula, Lomatogonium rotatum, Puccinellia paupercula, Spergularia canadensis, Stellaria humifusa, Triglochin* × *gaspense* and *T. maritimum.* The wet depressions and frequent tide pools, which form on the flats, contain colonies of aquatic species such as *Potamogeton filiformis, Ruppia maritima, Zannichellia palustris* and *Zostera marina.*

Most of the preceding species are halophytes which, by virtue of their tolerance to the severe conditions of the lower tidal mud flats, have been able to colonize this open habitat. The distribution of this unique assemblage of species is nearly exclusively restricted to this zone.

Upper Salt Marsh. The physiognomy of the upper salt marsh shoreline, which occurs at the upper limit of the tides, is quite different from that of the lower tidal flats because of its closed herbaceous structure. This community is rarely flooded by salt water but the soil is nevertheless saline and supports a diverse halophytic flora. The dominant species *Eleocharis halophila, Carex mackenziei, C. paleacea* and *C. salina* are accompanied by many other characteristic species such as *Arenaria peploides, Atriplex glabriuscula, A. patula, Carex maritima, Catabrosa aquatica, Glaux maritima, Iris hookeri, Juncus balticus, J. bufonius, J. gerardii, Lomatogonium rotatum, Plantago juncoides, Potentilla anserina, P. egedei, Sagina nodosa, Scirpus americanus, Stellaria humifusa* and *Triglochin maritimum.* This last zone abuts on normal coastal plain vegetation and consequently many species of general distribution are capable of invading it despite the limitations imposed by the brackish environment. Such opportunistic species as *Agros-*

tis alba, Aster foliaceus and *Festuca rubra* are frequent examples of species which encroach on this community from the mosaic of herbaceous communities along the coast.

Brackish Shores. The brackish sand or gravel shores are sparsely colonized by several halophytic species including *Arenaria peploides, Atriplex glabriuscula, A. patula, Cakile edentula, Elymus arenarius, E. virginicus, Glaux maritima, Hierochloe odorata, Hordeum jubatum, Ligusticum scothicum, Lathyrus japonicus, Mertensia maritima, Poa eminens, Polygonum fowleri, P. raii, Salsola kali, Sagina nodosa, S. procumbens, Senecio pseudo-arnica, Solidago sempervirens* and *Spartina pectinata.* These species are infrequent and are usually restricted to this open brackish habitat although a few, such as *Ligusticum scothicum* and *Lathyrus japonicus* are occasionally found growing on wet sea cliffs. Because these shores are often adjacent to the salt marsh, some of the same species occur in both habitats. This vegetation unit also grades into the mosaic of coastal herbaceous communities described by Bouchard (1974).

GEOGRAPHIC DISTRIBUTION. The forebay of St. Pauls Inlet and the entrance to Parsons Pond contain the only large saline mud flats with rich salt marsh vegetation. The St. Pauls flats (Figure 5B) are a particularly outstanding feature of the coastal plain.

Tidal mud flats are also located in Bonne Bay at Glenburnie and Lomond in the estuaries of Mackenzies Brook and the Lomond River respectively. Less extensive brackish shores are also found at the mouth of Deer Brook and in the Southeast Arm.

In the northern part of the District, the only locality where there is some minor development of this vegetation is in Hawkes Bay at the mouth of the East River.

Numerous brackish gravel shores occur in protected coves of Bonne Bay, St. Pauls Inlet, Parsons Pond, Port Saunders and Hawkes Bay. The only examples of brackish sandy shores lie in front of the sand dunes at Western Brook, Stanford River and Portland Creek.

Coastal Plain, Calcareous Exposures.

The calcareous exposures of the coastal plain are described in two subsections, calcareous maritime exposures (Figure 5C) and calcareous inland exposures (Figure 5D). Although these two habitats are characterized by calcareous bedrock, the maritime influence is such an important ecological variable that this division is necessary to adequately describe the flora.

Calcareous Maritime Exposures

PHYSIOGRAPHY. The geomorphology of the calcareous maritime exposures in the northern part of the coastal plain is very different from that in the southern sector. In the latter part of the region the exposures are promontories with low cliffs which jut out from the coastline. These headlands are the exposed, terminal sections of ridges of interbedded sedimentary rock which underlie the coastal plain. These ridges, which parallel each other in this part of the coastal lowland, are the result of thrust faulting and massive lateral displacement (klippen) of the interleaved sedimentary beds of several distinct geological formations. The geomorphology of this section of the coastal plain has been discussed in detail by Cumming (1973) and is summarized in the geology section of this text (see previous Geology section). In contrast the calcareous maritime exposures of the northern sector are extensive flat barrens which intermittently form long sections of the coastline. These barrens are composed of horizontal beds of the autochthonous sedimentary deposits of sandstone and carbonate rock which form the bedrock of the coastal plain in this northern sector (Fleming, 1973). They lie exposed and are maintained as barrens by the constant erosion processes of the seashore. The surface of this landform is a mosaic of bedrock outcrops and gravel barrens where frost weathering of the bedrock has led to the accumulation of unconsolidated gravel. The seaward section of these barrens may slope gradually to sea level or terminate as low sea cliffs.

Much of the floristic composition of the vegetation of these exposures is determined by the alkaline calcareous bedrock. Additional parameters which also have an important influence are the salt spray, due to the proximity of the sea, and the exposure to high winds which maintain the open, unstable nature of the habitat.

VEGETATION AND FLORA. Despite the differing geomorphology of the coastal calcareous exposures in the northern and southern halves of the region, their flora is very similar. The lower cliff face and boulder beaches of both the headlands and barrens are normally completely open. Only in protected coves of Pointe Riche Peninsula is there some development of brackish shore vegetation (see previous Tidal Flats section). The vegetation which becomes established behind the open seaward sector can be described in two principal zones: (1) the unstable upper cliff face and exposed rock barrens facing directly on the sea, and (2) the turfy heath scrub which stabilizes areas on the crest or top of the barrens and cliffs which are less disturbed. This heath community grades into the coastal formation of fir scrub situated inland of the exposed seaward zones.

Sea Cliffs and Rock Barrens. The steep sea cliffs are sparsely colonized on their upper face by a few hardy species such as *Plantago juncoides* and *Sedum rosea.* The latter is unique to this landform in the study area. On more protected high ledges there is some formation of turf composed of such ubiquitous coastal species as *Agrostis alba, Campanula rotundifolia, Festuca rubra, Ligusticum scothicum* and *Potentilla anserina.*

The weathered gravels and outcrops on the northern barrens support a more diverse flora than the previous habitat. They are colonized mainly by a very patchy vegetation cover of severely wind-pruned shrubs. The dominant species forming this low-lying mat include such rampant woody species as *Betula pumila, Juniperus communis, J. horizontalis, Potentilla fruticosa,* and the characteristic calciphile *Dryas integrifolia.* The latter species is a commonly occurring example of the calciphilous element of the flora, the distribution of which is restricted to this calcareous physiographic unit. The apparent rarity of these species, or at least their restriction to a unique habitat at various isolated localities around the Gulf of St. Lawrence, has attracted the attention of botanists such as Fernald (1925), Marie-Victorin (1938), Scoggan (1950), Damman (1965), Roland and Smith (1969), Rousseau (1974) and Grandtner and Rousseau (1975). Whether the edaphic specificity of this element of the flora is indicative of a particular physiological dependency on the calcareous substrate (calciphilous) or whether they are ecologically specialized plants which find sanctuary in this unstable, low-competition habitat, is a question which has long engendered debate (Wynne-Edwards, 1937, 1939; Griggs, 1940). More recently authors such as Drury (1969) and Morisset (1971, 1974) have discussed this group of vascular plants and the biogeographic implications of their endemism or disjunct distribution.

Most of the species occurring in the study area, which have been described as calciphiles in the Gulf of St. Lawrence region (Fernald, 1950; Scoggan, 1950; Rousseau, 1974), are found growing sparsely either on the open weathered gravels or shallow soils of the turf carpet overlying the barrens. The main examples are species which are characteristic of the biophysiographic unit as a whole in that they are found on these coastal sites and also on the inland calcareous sites. They include *Allium schoenoprasum, Arnica chionopappa, A. terrae-novae, A. tomentosa, Asplenium viride, Cypripedium calceolus, Cryptogramma stelleri, Cystopteris fragilis, Draba arabisans, D. glabella, D. norvegica, Erigeron hyssopifolius, Hedysarum alpinum, Lesquerella purshii, Malaxis brachypoda, Polystichum lonchitis, Salix vestita* and *Tofieldia pusilla.*

Other species such as *Carex microglochin, Cochlearia cyclocarpa, C. tridactylites, Gentiana nesophila, Habenaria hookeri, Parnassia parviflora* and *Salix reticulata,* though generally described as calciphilous, are restricted in their distribution to the maritime barrens and apparently are not found on the inland calcareous sites.

Another group of species which colonize this biophysiographic unit is also found growing sparsely on the serpentine tableland (see following Serpentine Tableland section). These species include *Arctostaphylos uva-ursi, Anemone parviflora, Arenaria humifusa, A. rubella, Armeria maritima, Artemisia canadensis, Cerastium arvense, Oryzopsis asperifolia, Oxytropis terrae-novae, Salix arctica, S. glauca, Saxifraga aizoides, S. oppositifolia, Senecio pauperculus, Solidago hispida* and *S. multiradiata* and show a close affinity with the strictly calciphilous species in that they colonize an open unstable habitat on a highly alkaline rock substrate.

The flora of this biophysiographic unit is very diverse and contains numerous species of wide arctic distribution which, though not defined as calciphiles, are restricted to this landform in the study area. The calcareous sites provide a favourable habitat at the limit of the range of *Arabis alpina, Artemisia borealis, Braya purpurescens, Carex rupestris, Festuca saximontana, Potentilla nivea, P. pectinata, Primula egaliksensis, Saxifraga cespitosa, S. paniculata, Sedum rosea, Woodsia alpina,* and *W. glabella* and permit their southern extension of distribution into the Gulf of St. Lawrence.

In addition to species which are characteristic or unique, these naturally disturbed open barrens are also successfully colonized by weedy species such as *Achillea millefolium*, *Deschampsia flexuosa* and *Trisetum spicatum* which are frequent in man-disturbed or open habitats everywhere on the coastal plain. Because some localized turfy areas are sufficiently influenced by salt spray from the sea, some species more typical of the salt marsh or gravel beaches (see previous Tidal Flats section) such as *Iris hookeri*, *Juncus balticus*, *Ligusticum scothicum*, *Mertensia maritima* and *Scirpus rufus* may be found.

Turfy Heath Scrub. The turfy heath scrub, which lies behind the seaward-facing gravel barrens and cliffs, is a structurally closed vegetation unit on a hummocky peat layer on the calcareous maritime exposures. The vegetation of this zone is permanently maintained as a poorly developed low-lying scrub and peaty turf due to exposure to high winds and frost kill. The peaty carpet is sufficiently removed vertically from the underlying limestone so that in comparison with the open gravel barrens, the flora in this zone is much more diverse. Fernald (1933) attributes the reduced alkalinity of these superficial soils to leaching and accumulation of acid peats. As a result the turfy heath barren is dominated by a wind-pruned scrub composed of species of general distribution such as *Abies balsamea*, *Betula pumila*, *Empetrum nigrum*, *Juniperus communis*, *J. horizontalis*, *Larix laricina*, *Myrica gale*, *Picea mariana*, and *Potentilla fruticosa*. Uncommon but characteristic shrubs include *Cornus alba*, *Rhamnus alnifolius*, *Shepherdia canadensis* and *Viburnum edule*. Ericaceous species such as *Andromeda glaucophylla*, *Vaccinium angustifolium*, *Kalmia angustifolia* and *Ledum groenlandicum* which characterize the raised bogs of the coastal plain (see following section on Peatlands) are relatively common in this heath scrub formation. Several uncommon herbaceous species including *Castilleja septentrionalis*, *Comandra richardsiana*, *Geocaulon lividum* and *Selaginella selaginoides* are not considered as calciphiles but often favour calcareous boggy soil. They have a general distribution in the study area but are more frequently found in the protective heath scrub of these calcareous barrens.

GEOGRAPHIC DISTRIBUTION. The calcareous coastal headlands in the southern half of the coastal plain are situated at isolated localities between Bonne Bay and Parsons Pond. These scarped promontories jut into the Gulf at Lobster Cove Head, Green Point,

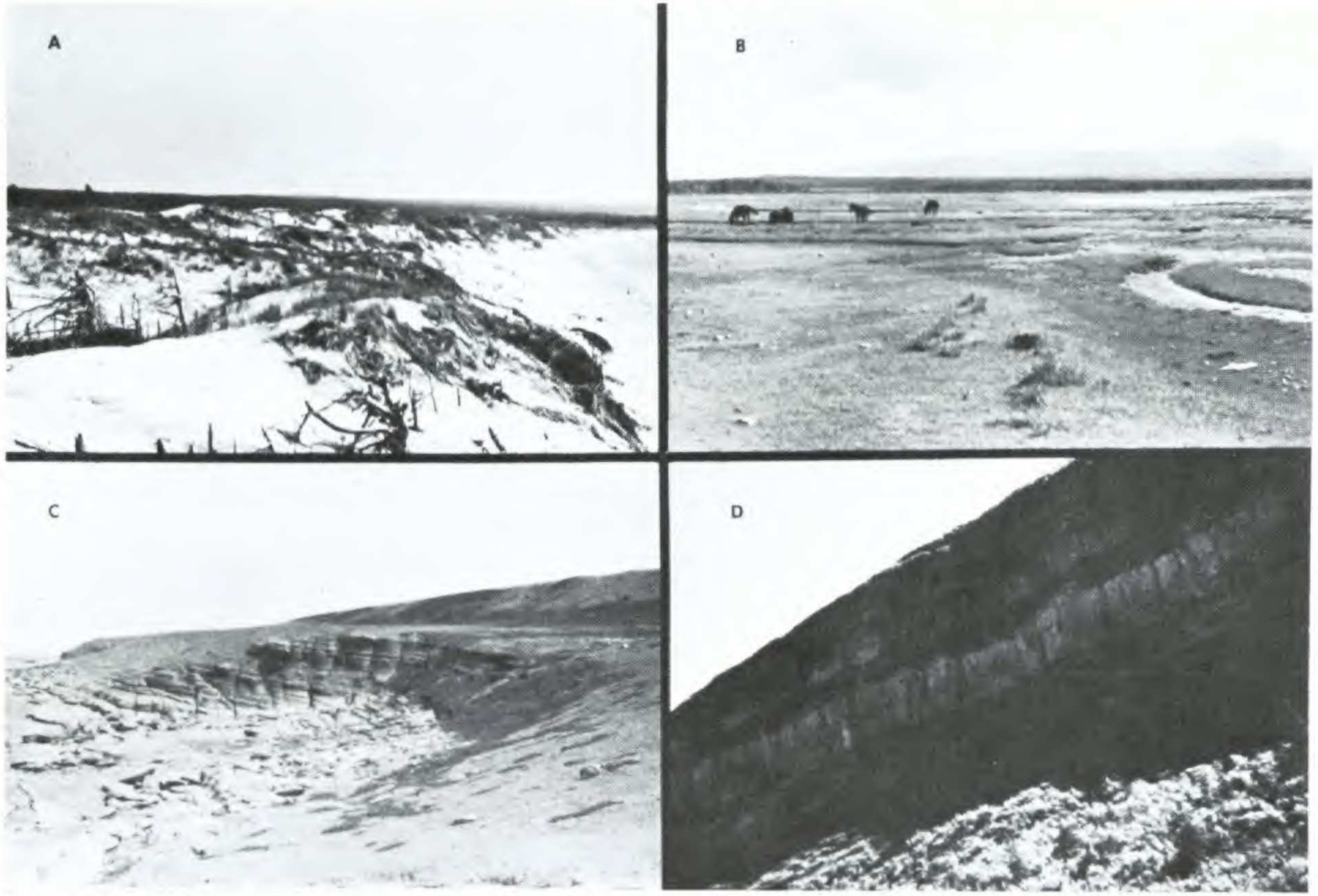

Figure 5. A, Sand dunes at Shallow Bay. B, St. Pauls tidal flats at low tide. C, Limestone barrens at Pointe Riche. D, Limestone escarpment along the South Summit of the Highlands of St. John.

Martin Point, Broom Point, Cow Head and Lower Head. Stearing Island and White Rock Islets at Cow Head are part of the same formation.

The coastal limestone barrens of the northern sector are much more extensive tablelands and constitute long sections of the seashore. The Eastern Head formation extends from Portland Creek to Daniels Harbour. Bateau Barrens dominates the coastline between Bellburns and Bateau Cove at LaFontaine Point. The Pointe Riche Peninsula (Figure 5C) at Port au Choix, including the barrens on the mainland between Gargamelle and Eddie's Cove West, is the largest exposure of this landform.

Calcareous Inland Exposures

PHYSIOGRAPHY. The inland calcareous exposures of the study area are major outcrops of sedimentary rock which lie at scattered locations along the western escarpment of the Long Range Mountains. They are not a continuous geological formation but rather occur as local exposures along the thrust fault which divides, from north to south, the low-lying sedimentary coastal plain and the Precambrian Long Range plateau. With the uplift of the Long Range, sections of the coastal lowland, lying along the fault, were displaced. Less major displacements along the fault have been reduced by erosion to hogback foothills (Cumming, 1973) along the base of the escarpment and are covered with fir scrub or fir forest vegetation. The major displacements are still represented by vertical cliffs of interbedded shale, limestone and sandstone with steep talus slopes at their base. Despite the almost montane elevation of a few of these cliffs, this landform is treated as part of the coastal plain complex because these displaced sedimentary formations are closely allied geologically with the calcareous exposures of the actual coastal lowland.

The sedimentary cliffs and their talus slopes constitute an extremely unstable habitat because of the continual disturbance by exposure, ice and falling rock. Consequently the vegetation cover is minimal and it is maintained in a pioneer stage of succession. The drainage of this habitat is rapid.

The vegetation shows no maritime influence because these outcrops are situated along the interior of the coastal plain and well inland from the sea. The outcrops exposed around the East Arm of Bonne Bay are somewhat exceptional because this basin opens directly onto the sea and the bay is partly saline. Nevertheless, the flora of these latter scarps is similar to the more strictly interior examples of this landform.

VEGETATION AND FLORA. The boulder screes at the base of these calcareous cliffs are usually covered on their lower slopes by fir forest or fir scrub vegetation, which towards its upper extreme grades into patchy dwarf scrub composed usually of *Abies balsamea, Betula papyrifera, Juniperus communis, Picea glauca* and *P. mariana*. Above this stabilized area, the talus slope and vertical cliff face are completely open and the vegetation cover is less than 5%. The lack of dominant species and a high diversity of uncommon or rare species, including a rich calciphilous element, characterize this vegetation. Those calciphiles which have ubiquitous distribution on calcareous sites within the region, whether they be coastal headlands or inland exposures, have been described for the coastal calcareous exposures (see previous Calcareous Maritime Exposures section). Conversely, examples of those species which are conceived to be true calciphiles by several authors (Fernald, 1950; Rousseau, 1974; Scoggan, 1950) and whose distribution is restricted to the rocky ledges and crevices of this physiographic site include *Alchemilla minor, Androsace septentrionalis, Anemone multifida, Arabis drummondii* and *Cystopteris bulbifera*. Within the study area, these species apparently cannot tolerate the ecological influence of salt spray and increased exposure which are important factors in the corresponding coastal habitats.

The crest and flat summit of these outcrops often provide a more stable, undisturbed site for colonization by fir scrub or fir forest communities similar to those found at the base of the talus slopes and elsewhere on the coastal plain. The barren summit of Sandy Barren at St. Pauls Inlet is exceptional and its sparse vegetation cover is strikingly similar to that of the exposed maritime rock barrens.

GEOGRAPHIC DISTRIBUTION. The East Arm basin of Bonne Bay provides some of the most striking examples of this landform with high stratified cliffs and steep talus slopes at Lomond, Tuckers Head, and Shag Cliff along the south shore; and at Killdevil along the north shore.

Further north, major exposures occur at Sandy Barren at the interior end of St. Paul's Inlet and at the eastern end of Parsons Pond where these basins meet the escarpment of the Long Range plateau.

The cliffs of the sedimentary outcrop at Portland Head are curiously isolated in the coastal plain but are probably indirectly associated with the major fault dividing the coastal lowland and the Long Range.

The most northern and most extensive exposure in the study area is the western escarpment of Doctor Hill, the South Summit of the Highlands of St. John (Figure 5D).

Coastal Plain, Peatlands.

The following description of this biophysiographic unit is a simplified version of that which appeared in previous reports on the vegetation and flora of the coastal plain of Gros Morne National Park (Bouchard, 1974, 1975; Bouchard and Hay, 1976a). It has been expanded to fit the description of the entire coastal lowland of the study area.

PHYSIOGRAPHY. Fen and bog peatland overlie much of the coastal plain (Figure 4A) forming a patchwork of flat, wet herbaceous terrain between adjacent forest and scrub communities.

Except for a few exposed rock ridges and coastal headlands, the bedrock foundation of the coastal plain lies buried beneath deep marine and glacial deposits. Its geomorphology is an important factor controlling the drainage and hence the formation of these peatlands (Bouchard, 1975). The complex geology of the sedimentary bedrock formations and of the mantle of surficial deposits has been summarized in the geology section (see previous Geology section) of this text and has been discussed in detail by Cumming (1973) and Grant (1972a, 1973a).

The most extensive peatland formations occur in the southern and central part of the coastal plain where in some areas these organic deposits cover as much as 43% of the terrain (Bouchard, 1975). The peat deposits usually lie between adjacent outcrops of parent bedrock or glacial deposits which are more elevated and better drained landforms. Many of the bogs in this sector are of a linear pattern due to their formation between ridges created by the faulted bedrock. In the northern sector the deep surficial moraines of glacial till, which mantle most of this coastal plain area (Grant, 1972a), have greatly limited the development of peatlands.

The coastal plain bogs may have been formed following the same successional steps described by Sjörs (1963) for the Attawapiskat River in northern Ontario (Bouchard, 1974). Forest or scrub would have invaded the newly exposed land after its post-glacial emergence from the sea. Much of this early forest was probably swampy. The peaty but well decomposed types of humus made the soil more impermeable and more water retaining. The general development was then in the direction of greater wetness or paludification. Mosses spread (as the conditions that allowed their establishment continued), gradually occupying more and more of the forest floor until the sodden conditions killed off the forest and a bog was formed (Drury, 1956). Most of the peatland can be classified as "raised bogs." These bogs have grown above their site of origin, and have centers which are higher than the margins and surfaces which are convex (Drury, 1956). Growth is by peat-moss proliferation and deposition of peat. Deposit depth varies tremendously and can exceed 3.5 meters. The high rate of peat decomposition on the edge of the raised bog is probably the cause of the convexity of the dome. Numerous flashets or ponds are found at right angles to the slope in the direction of the contours. According to Sjörs (1961), the flashets are primarily dependent on the water flow across the peatland. The poor drainage in these ombrogenous bogs is by seepage from the center to the edge.

Sjörs (1963) wrote that "if the present non-glacial period continues long enough, growing peat deposits will ultimately reach a state of instability inducing either drought or bog-burst, depending on the type of topography and climate. In many cases the peats will be destroyed earlier by erosion, corrosive oxidation, or fire thus never reaching a final state of maturity." Because of the short growing season and low nutrient conditions, successional changes are expected to be extremely slow. The present structure and composition will be maintained for a long period of time.

The vegetation on the flat, wet terrain of the peatlands can be zonally subdivided according to the trophic level of the site. Pollett *et al.* (1970) have made a detailed analysis of peatland vegetation based on this principle. In this study a somewhat simpler segregation is adopted: (a) the large raised bogs and adjacent surrounding dwarf black spruce scrub which are the predominant community types on wet, oligotrophic sites; and (b) sedge meadows (or fens) and larch scrub which favour the richer eutrophic sites.

VEGETATION AND FLORA.

Raised Bogs. The physiognomy of the raised bog landform is distinct as an expansive, hummocky blanket of *Sphagnum* peat and reindeer moss (*Cladina*) with very dwarf vegetation of tundra type structure. The dominant herbaceous vascular species composing the vegetation cover is *Scirpus cespitosus.* Several dwarf ericaceous shrubs such as *Andromeda glaucophylla, Chamaedaphne calyculata, Empetrum nigrum, Kalmia angustifolia, K. polifolia, Ledum groenlandicum, Vaccinium angustifolium, V. oxycoccos* and *V. uliginosum* are also dominant or very frequent species. These woody plants are maintained in an extremely dwarf or stunted stage of development due to the low nutrient level and exposure to high wind and frost kill in the bogs. Rarely will these species exceed 5 cm. in height (Bouchard, 1974). Less common or infrequent dwarf shrubs including *Abies balsamea, Aronia melanocarpa, Betula pumila, Gaylussacia dumosa, Juniperus communis, Larix laricina, Lonicera villosa, Myrica gale, Nemopanthus mucronatus, Picea mariana* and *Vaccinium vitis-idaea* are characteristic of the vegetation of the raised bogs. The wetness of the habitat favours the colonization by several important Cyperaceae such as *Carex aquatilis, C. exilis, C. limosa, C. rariflora, Eriophorum angustifolium, E. spissum, E. virginicum* and *Rhynchospora alba.* Other frequent and characteristic vascular plants of the flora include *Arethusa bulbosa, Aster nemoralis, Coptis groenlandica, Drosera rotundifolia, Equisetum fluviatile, Rubus chamaemorus, Sarracenia purpurea* and *Smilacina trifolia.*

The raised bogs are usually surrounded by a belt of dwarf black spruce scrub (Figure 4C) in which ericaceous shrubs are co-dominants. This community, which is maintained as a dwarf formation less than 50 cm. in height (Bouchard, 1974) due to the pruning action of the wind, grades into taller more pure formations of black spruce scrub. The dominant species in the dwarf scrub formation are *Kalmia angustifolia* and *Picea mariana.* Ericaceous shrubs such as *Chamaedaphne calyculata, Empetrum nigrum, Ledum groenlandicum, Vaccinium angustifolium* and *V. vitis-idaea* are common accompanying species. The flora of this association is not rich and is very similar to that of the raised bog proper.

Several uncommon but characteristic shrubs not encountered in the raised bog include *Alnus rugosa, Amelanchier bartramiana, Juniperus horizontalis, Rhododendron canadense* and *Viburnum cassinoides*. Additional infrequent herbaceous species such as *Geocaulon lividum, Linnaea borealis* and *Sanguisorba canadensis* are also found in this more protected habitat.

Sedge Meadows. The sedge meadows (or fens) are not common on the coastal plain, nor do they cover large areas in contrast with the raised bogs. They are found primarily in well mineralized, eutrophic zones having active water seepage (Pollett *et al.*, 1970) such as depressed "lagg" areas adjacent to the raised bogs or floating vegetation mats around ponds or lakes.

The vegetation on this flat, wet habitat is primarily herbaceous and dominated by one or several cyperaceous species such as *Carex exilis, C. lasiocarpa, C. livida* or *Scirpus cespitosus*. The community has a tendency to develop towards a shrub-carr by the invasion of woody plants (Curtis, 1959). As a result such shrubby species as *Andromeda glaucophylla, Aronia melanocarpa, Betula michauxii, B. pumila, Chamaedaphne calyculata, Empetrum nigrum, Kalmia polifolia, Larix laricina, Ledum groenlandicum, Lonicera villosa, Myrica gale* and *Picea mariana* are common accompanying species. The flora of these communities is one of the richest of vegetation types found on the coastal plain. In addition to *Aster nemoralis, A. radula, Drosera anglica, D. rotundifolia, Menyanthes trifoliata, Sanguisorba canadensis, Scirpus hudsonianus* and *Vaccinium oxycoccos*, many other vascular plants listed by Bouchard (1974) are found which are characteristic of this hydric flora.

The sedge meadow communities often grade into an adjacent larch scrub formation. These two vegetation types have much the same floristic composition but their structure is quite different, the latter being an open scrub formation dominated in the shrub stratum by *Larix laricina*. Other common shrub species are *Betula pumila, Ledum groenlandicum, Myrica gale, Potentilla fruticosa* and *Rhamnus alnifolius*. *Drosera rotundifolia, Equisetum fluviatile, Galium labradoricum, Gaultheria hispidula, Iris versicolor, Mitella nuda, Sanguisorba canadensis, Scirpus cespitosus, Smilacina trifolia, Solidago uliginosa, Thalictrum alpinum, T. pubescens, Triglochin maritimum* and *Vaccinium oxycoccos* dominate the rich ground flora. Many sedges such as *Carex disperma, C. interior,* *C. lasiocarpa, C. leptalea, C. limosa, C. livida* and *C. tenuiflora* are a common element of this habitat. The added protection afforded by this shrub phase of the sedge meadow and its nutrient enriched seepage, which is often calcareous, may partially explain the colonization by many species which are mostly restricted to this zone in the peatlands. *Angelica atropurpurea, Caltha palustris, Epilobium palustre, Pinguicula vulgaris, Salix candida, Selaginella selaginoides* and orchid species such as *Cypripedium reginae, Habenaria dilatata* and *Listera convallarioides* are examples of this latter group.

GEOGRAPHIC DISTRIBUTION. The peatlands overlie the entire coastal lowland but are most extensive in the southern and central regions of the study area. The major formations extend from Rocky Harbour in the south to Daniels Harbour in the central sector of the District. Back from the coastline, this landform stretches inland from one to fifteen kilometers toward the base of the Long Range escarpment. To the north of Daniels Harbour, this biophysiographic unit becomes less important although there is some development south of River of Ponds and to the interior of Hawkes Bay.

Coastal Plain, Freshwater Areas.

PHYSIOGRAPHY. The watershed of the coastal plain is an interconnected network of freshwater rivers, streams and ponds which constitutes much of the surface area. The complex drainage patterns are determined by the underlying sedimentary bedrock formations and the surficial marine and glacial deposits.

Running Water. The major drainage basins of the coastal lowland are associated with the rivers draining the land-locked, freshwater fjords (Figure 4A). Water from the rivers is supplied mainly by these fjords which are reservoirs of the nutrient-poor meltwater from the high altitude, granitic Long Range plateau. The rivers are also fed by the network of meandering streams and creeks which dissect the wet peatlands of each drainage basin.

Standing Water. The abundant lakes, ponds and bog pools (or flashets) in the lowland area are filled by accumulated spring meltwater and summer precipitation. The larger ponds and lakes are generally shallow depressions in surficial glacial till and the bottoms are covered with a mineral substrate. The high water retaining capacity of the surrounding peatlands assures a slow run-off and maintains a high water table and a constant water supply to these ponds throughout the summer. Occasional marl ponds have formed in areas where there has been an accumulation of calcium rich, alkaline seepage water from underlying calcareous bedrock. The forebays, which lie at the mouths of several of the landlocked fjords, form the deepest and largest bodies of freshwater in the coastal plain. The numerous flashets, which characterize the physiognomy of the raised bogs, are depressions of varying depth which are formed in the peat deposits due to the eccentric growth and drainage of the bogs (see previous Peatlands section). Some of these pools may be completely drained during the summer, exposing the partially decomposed peat deposits of the bottom.

VEGETATION AND FLORA.

Running Water. The rivers and larger streams of the coastal plain support little or no aquatic vegetation due to limiting physical conditions such as swift current or rapids, sterile sandy or rocky substrate, and the low nutrient level. Where large ponds (locally called "steadies") form in the river bed and physical factors become less restrictive, aquatic vegetation similar to that which colonizes the edge of lakes may become established.

Despite the virtual absence of any hydrophytic vegetation in the rivers, the narrow fringe of alluvial soils along these drainage courses may be extensively colonized by *Alnus rugosa* thickets. Other woody species characteristic of this riparian zone include *Cornus alba, Rhamnus alnifolius, Salix cordata* and *S. pellita.* Pteridophytes such as *Onoclea sensibilis* and *Matteuccia struthiopteris* occasionally form an important ground cover. Some species which are mainly restricted to this habitat in the study area are *Cirsium muticum, Corylus cornuta, Dryopteris thelypteris, Eupatorium maculatum, Lycopus americanus, Mentha arvensis, Scutellaria epilobiifolia, S. lateriflora* and *Trillium cernuum.* Though not strictly situated in the coastal plain, the river estuaries of Bonne Bay are colonized by similar alder swales. *Fraxinus nigra* and *Sambucus pubens* are found in this habitat and appear to reach the northern limit of their distribution in Newfoundland at Bonne Bay.

The oligotrophic, meandering creeks, which drain the wet peatlands, are not significant for aquatic flora although a few true hydrophytes such as *Potamogeton alpinus, P. natans* and *Hippuris vulgaris* may become established in the slow flowing water. On the banks of these entrenched channels a characteristic community develops. This vegetation unit, as described by Bouchard (1974), is a scrub formation dominated by *Alnus rugosa, Calamagrostis canadensis, Myrica gale, Sanguisorba canadensis, Spiraea latifolia* and *Thalictrum pubescens.*

Standing Water. The freshwater lakes and ponds of the study area can be described as oligotrophic, eutrophic and dystrophic as defined by Dansereau (1957). The deep fjord basins are oligotrophic bodies of water. They contain no vascular plants although occasional species such as *Isoëtes muricata* may rarely colonize shallow water areas along the edge of their forebays.

Most of the larger lakes and ponds of the coastal plain are more eutrophic. They contain some shoreline vegetation but it is variable and shows no uniformity from one pond to another. Some of the more common emergent hydrophytes are *Carex aquatilis, Eleocharis palustris* and *Equisetum fluviatile.* Uncommon to rare species such as *Callitriche verna, Eriocaulon aquaticum, Glyceria borealis, Littorella americana, Lobelia dortmanna, Myriophyllum alterniflorum, M. exalbescens, M. tenellum, Potamogeton amplifolius, P. epihydrus, P. gramineus, Ranunculus trichophyllus, Sagittaria graminea, Scirpus acutus, Sparganium minimum* and *Utricularia vulgaris* are found locally in the shallow water of these ponds. Occasional lakes are bordered by areas of emersed muck deposits. In this littoral zone, uncommon but characteristic species such as *Caltha palustris, Cardamine pensylvanica, Carex michauxiana, Glyceria canadensis, Hypericum boreale, Juncus pelocarpus* and *Ranunculus reptans* are found in a sparse herbaceous community where sedges such as *Carex aquatilis, C. flava* and *C. lasiocarpa* predominate.

The dystrophic pools and flashets in the raised bogs harbour a very limited flora due to their acidity and nutrient deficiency. Those which are shallow often contain emergent hydrophytes such as *Carex limosa, C. rostrata, Equisetum fluviatile* and *E. palustre.* Occasional species which are found either anchored in the organic peat bottom or floating in the shallow water of these pools include *Drosera rotundifolia, Menyanthes trifoliata, Nuphar variegata, Sparganium angustifolium, S. hyperboreum, Triglochin palustre, Utricularia cornuta, U. intermedia* and *U. minor.*

GEOGRAPHIC DISTRIBUTION. The rivers which drain the major landlocked fjord basins as well as the surrounding coastal plain are Deer Brook, Bakers Brook, Western Brook and Portland Creek. Stag River, Stanford River, River of Ponds and Torrent River drain only the coastal plain and are not connected to the fjords.

The largest freshwater lakes or ponds are the forebays at the mouths of the major fjords. They are found at Deer Pond, Bakers Brook Pond, Western Brook Pond, Portland Creek Pond, Western and Eastern Blue Pond. Lakes which occur along the drainage course of a river, such as River of Ponds Lake and the Torrent River Lakes, are common in the coastal plain.

Coastal Plain, Forested Moraines, Ridges and Foothills.

PHYSIOGRAPHY AND GEOGRAPHIC DISTRIBUTION. Within the coastal plain, much of the surface area is occupied by several elevated landforms including glacial moraines, bedrock ridges and foothills of the Long Range escarpment. Because of several shared features, these distinct landforms have been grouped together as a single biophysiographic unit despite the unique geomorphology of each. Their mineral soils, improved drainage and their elevated sloping topography (compared with adjacent low-lying peatlands) constitute a habitat which has been pervasively colonized by several similar vegetation types, usually dominated by *Abies balsamea* and *Picea mariana.*

Low, rolling ground moraines covered by forest and scrub vegetation are typical of this biophysiographic unit. These sites are more common in the central and northern sector of the coastal plain (Grant, 1972a). Other major landforms with similar physiography are elevated marine beaches, weathered ridges of faulted sedimentary bedrock and frontal slopes and foothills of the Long Range escarpment including the heads of the fjord valleys. The forested slopes and valleys surrounding much of Bonne Bay, although situated outside the coastal plain area, are included in this general biophysiographic unit.

These landforms are found throughout the altitudinal range of the coastal plain. They have been described as separate, detailed land systems in the southern part of the study area located within Gros Morne National Park (Airphoto Analysis Associates, 1975).

VEGETATION AND FLORA. Although this general biophysiographic unit represents a somewhat arbitrary grouping of heterogeneous landforms, the floristic composition of the colonizing forest and scrub vegetation is very constant. Nevertheless, the structure of the forest or scrub vegetation found on the different landforms is variable depending mainly on the level of disturbance which has occurred. Three major formations can be distinguished: (1) second growth, closed-crown forests of *Abies balsamea* which colonize most of the inland examples of this biophysiographic unit where wind is not an important controlling factor; (2) wind-shaped krummholz (Figure 4 D) colonizing the coastal fringe of elevated beaches and moraines which are highly exposed to onshore winds; and (3) early successional scrub colonizing these sites which have been disturbed by man as a result of fire or logging.

Closed-crown Balsam Fir Forests. The most representative examples of this forest association are found on the frontal slopes of the Long Range escarpment where secondary succession has replaced the disturbance of past logging. Continued logging of the more accessible forested parts of the coastal lowland has maintained the vegetation in early successional scrub communities.

The closed-crown forests are typically dominated by *Abies balsamea* and *Betula papyrifera*. *Picea glauca* and *Picea mariana* are scattered throughout. Quantitative data concerning this vegetation type has been tabulated by Bouchard (1974), who concluded that mature forests of this type represent the terminal successional stage for this biophysiographic unit.

The ground flora of these forests is not rich, but a typical boreal forest element is well represented. *Dryopteris spinulosa* is very common and may dominate the herb layer. Other herbs of these latter forests are *Clintonia borealis*, *Coptis groenlandica*, *Cornus canadensis*, *Linnaea borealis*, *Maianthemum canadense*, *Trientalis borealis;* infrequent boreal orchids (*Goodyera repens*, *G. tesselata*, *Habenaria obtusata*, *Listera cordata*) and several ericaceous species (*Gaultheria hispidula*, *Moneses uniflora*, and *Monotropa uniflora*) comprise the majority of sparse ground cover. Several uncommon to rare species such as *Aralia nudicaulis*, *Corallorhiza maculata*, *Dryopteris phegopteris*, *Habenaria orbiculata*, *Lycopodium lucidulum*, *L. obscurum*, *Mitella nuda*, *Pyrola minor*, *P. secunda*, *Solidago macrophylla*, *Streptopus amplexifolius*, *S. roseus* and *Viola renifolia* are typically associated with these forests.

Understory shrub coverage is very sparse and is composed largely of regeneration from the canopy trees. Other occasional shrubs which are typically associated with this forest formation are *Acer spicatum, Alnus crispa, Nemopanthus mucronatus, Pyrus decora, Ribes glandulosum, R. lacustre* and *Taxus canadensis.*

Within the study area, these forests include several species which appear to be at or near the extreme northern limit of their Newfoundland distribution. *Acer rubrum, Betula alleghaniensis, Epigaea repens, Pinus strobus* and *Populus tremuloides* have been recorded from only rare stations at Bonne Bay.

A transition black spruce scrub community (Figure 4 C) lies in a buffer zone between the balsam fir forest of the richer, better drained sites and the dwarf black spruce scrub of the oligotrophic peatland soils (see previous Peatlands section). Its physiognomy differs sufficiently from the adjacent formations in that it has been described as a discrete vegetation type by authors such as Damman (1967) and Bouchard (1974, 1975). Although it is a continuum between the two adjacent vegetation types, the flora of this transition scrub more closely resembles the dwarf black spruce scrub than the fir forest community. *Abies balsamea* is an important element but *Picea mariana* becomes the dominant species in this transition zone. There is also a predominance of ericaceous shrubs such as *Kalmia angustifolia* and *Ledum groenlandicum* which is indicative of its close relationship to the adjacent dwarf black spruce scrub community.

Wind-shaped Coastal Krummholz. The wind-shaped component of the balsam fir forests and scrub includes the coastal krummholz and the upland tuckamoor. Both communities are physiognomically and botanically similar but only the former occurs in the coastal plain.

The coastal krummholz is found mainly on elevated beaches and reworked moraines along the seashore. Similar stands are found where these landforms occur around large bodies of water in the coastal plain. Settlement and logging have decimated many of the former stands of this vegetation type. The exposure to the pruning action of high winds and frost kill is responsible for the notable flattened crown of this scrub formation.

The dominant tree species is *Abies balsamea. Picea glauca* is frequent and may dominate some small isolated stands. It is noteworthy that *Picea mariana* does not occur in this scrub formation. Botanically, these isolated wind-disturbed communities are not as rich as the homologous, protected forest stands. Nevertheless, species which are common in the latter forest communities, such as *Dryopteris spinulosa, Maianthemum canadense, Moneses uniflora,* etc. also comprise the sparse ground flora of the krummholz.

Early Successional Scrub. The closed-crown balsam fir forests of this biophysiographic unit were formerly more widespread on the coastal plain. Due to continued logging of these accessible areas, many of the original stands are now maintained as early successional scrub communities dominated by *Abies balsamea.* These were described by Bouchard (1974) as homogeneous second growth scrub of balsam fir and heterogeneous second growth scrub of balsam fir and deciduous shrubs. Because balsam fir can reoccupy almost all sites occupied before logging (Damman, 1967), this scrub vegetation is a successional step toward the closed-crown balsam fir forest. Consequently the flora of this community is composed of essentially the same species which comprise the fir forests. The open structure of the heterogeneous second growth scrub permits an increase in frequency of invading deciduous shrubs such as *Acer spicatum, Alnus crispa, A. rugosa* and *Betula papyrifera.*

Fire-disturbed areas are infrequent. Their occasional occurrence on formerly forested moraines, such as in the area south of Western Brook Pond, has led to recolonization either by a heterogeneous *Betula papyrifera-Alnus crispa* dominated scrub or by *Kalmia angustifolia-Vaccinium angustifolium* dwarf scrub communities (Bouchard, 1974). These burned site communities are likely early successional stages toward balsam fir forest and black spruce dwarf scrub, respectively, as their evolving flora is much the same as the previously described flora of these latter natural communities.

Additional studies concerning the structure, composition and reconnaissance of these vegetation types within Gros Morne National Park have been done by Bouchard (1974, 1975) and Airphoto Analysis Associates (1975).

Alpine Plateau, Tundra Barrens.

PHYSIOGRAPHY AND GEOGRAPHIC DISTRIBUTION. The barrens of the Long Range Mountain plateau are the most characteristic feature of the highland landscape (Figure 6 A). The principal landforms of this biophysiographic unit are glacially scoured bedrock ridges and knobs often covered with thin deposits of surficial glacial drift and extensive flat boulder fields (or felsenmeer) of frost-shattered bedrock.

Within the study area, this biophysiographic unit is mainly concentrated in two widely separated areas of the Long Range plateau. In the northern sector, the barrens are found on the Highlands of St. John and the extensive plateau area to the interior. The second major area is found on that section of the plateau which lies between Bonne Bay and Portland Creek Pond. Some of the higher plateau surfaces in both regions are possible nunataks (periglacial ice-free zones) of the Wisconsin phase of Pleistocene glaciation (Airphoto Analysis Associates, 1975; Grant, 1969 a, b, 1973 a).

The shattered quartzite (felsenmeer) crests of Killdevil, Gros Morne and the South Summit of the Highlands of St. John (or Doctor Hill) as well as the barren highland peaks south of Bonne Bay at Lookout Hills and at Pic à Teneriffe are of different geological formations than the Precambrian Long Range plateau. Nevertheless, these outlying alpine peaks and the barrens of the main Long Range massif have been grouped into the same unit because of their botanical and physiographic similitude. The complex geomorphology of these highland areas has been summarized previously in section Geology.

Much of the surface of the barrens is exposed, lichen-covered bedrock. The major factors maintaining the colonization of these sites by tundra vegetation are the open exposure of the habitat and the inadequate, patchy veneer of gleyed, mineral soil. Due to the impervious granitic bedrock, the shallow siliceous soils are poorly drained. Savile (1972) and Bliss (1962) describe other pertinent physical factors such as wind abrasion and desiccation, low summer and winter temperatures and short growing period which are typical of this arctic-like environment. Barrens occur almost exclusively in the highland area but several isolated stations of limited size are found in the coastal plain area (Bouchard, 1974). These rare localities are on elevated, exposed knolls of the piedmont moraines situated in the foothills of the Long Range escarpment.

Zones of snow accumulation (or zabois) often occur on sheltered slopes or ravines adjacent to the barrens on the highland plateau. These protected sites are distinguished from the barrens per se by

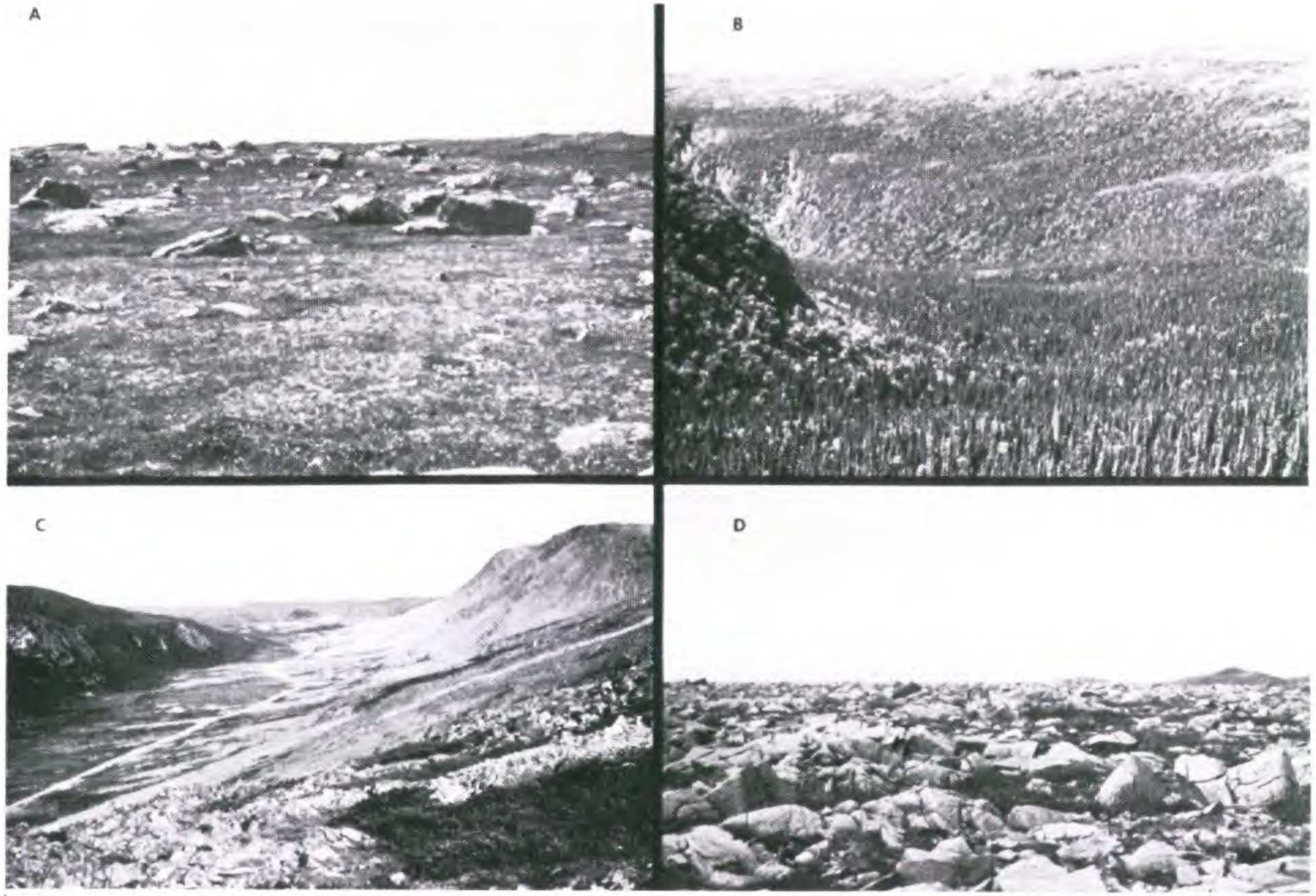

Figure 6. A, Alpine tundra barrens, Long Range Mountains. B, Forested valley within the Long Range Mountain plateau. C, Serpentine talus slopes between Trout River and Bonne Bay. D, Serpentine barren on the summit of Table Mountain.

snowbanks which may persist well into the summer, pockets of accumulated soil, and frequent wet seepage areas. Local differences in temperature and effective growing season in this unique habitat within the barrens have been discussed by Bliss (1969) for alpine peaks in the Appalachians.

VEGETATION AND FLORA. The tundra community which colonizes the highland barrens presents a generally discontinuous 60-80% vegetation coverage with intervening bare rock surfaces. The patchy heath carpet is consistently dominated by lichens (*Cladina alpestris, C. rangiferina,* etc.), mosses (*Rhacomitrium lanuginosum,* etc.), and dwarf ericaceous shrubs (*Empetrum nigrum* and *Vaccinium uliginosum*). Although the latter dwarf shrub species are quite ubiquitous throughout the study area, they typically dominate the severely wind-pruned vegetation of this biophysiographic unit.

The attenuated flora of this alpine community is remarkable for its characteristic arctic-alpine element. The xerophytic adaptations of many of these plants to the arid conditions of this habitat have been described by Bliss (1962), Porsild (1964, 1969), and Savile (1972). Such species as *Arctostaphylos alpina, Carex bigelowii, Diapensia lapponica, Empetrum eamesii, Juncus trifidus, Loiseleuria procumbens* and *Potentilla tridentata* are common. Less frequent examples include *Agrostis borealis, Hierochloe alpina, Lycopodium annotinum* var. *pungens* and *L. selago.* With the exception of *Potentilla tridentata,* these species are largely on the limit of a wide-ranging, arctic circumpolar distribution (Hultén, 1962, 1971; Porsild, 1964). Their range extends southward in isolated, suitable alpine habitats such as occur around the Gulf of St. Lawrence. Other uncommon species in this community (*Lycopodium sabinifolium* and *Salix uva-ursi*) are of eastern American arctic-alpine distribution (Rousseau, 1974).

Despite the severity of the habitat, several non-alpine or boreal herbaceous species sporadically colonize the barrens. These include *Cornus canadensis, Deschampsia flexuosa, Eriophorum spissum, Maianthemum canadense, Rubus chamaemorus, Scirpus cespitosus* and *Trientalis borealis.* Infrequent dwarf shrubs of the patchy vegetation mat are represented by *Abies balsamea, Betula papyrifera, B. pumila, Juniperus communis, Kalmia angustifolia, Ledum groenlandicum, Picea mariana, Vaccinium angustifolium* and *V. vitis-idaea*. These species encroach on the barrens community from adjacent sheltered ravines and slopes which are colonized by upland tuckamoor thickets.

In the zabois or snowbank zones, the tundra vegetation of the adjacent barrens grades into a richer, predominantly herbaceous community. This habitat falls within the tolerance limits of subalpine as well as alpine species (Bliss, 1969) and consequently the vegetation is usually dominated by species such as *Dryopteris spinulosa* and *Sanguisorba canadensis*. *Calamagrostis canadensis, Clintonia borealis, Coptis groenlandica, Polygonum viviparum, Solidago macrophylla, Streptopus amplexifolius* and *S. roseus* are some of the common non alpine herbs making up the diverse flora of this community. Dwarf ericaceous shrubs such as *Kalmia polifolia* and *Vaccinium angustifolium*, and patchy areas of turf dominated by *Scirpus cespitosus* are also found in this heterogeneous vegetation. *Alnus crispa* thickets sometimes colonize the lower slopes or meltwater drainage channels in these zabois areas. The tundra barren species grade into this community. In addition, these protected sites harbour several rare alpine species which have been recorded mainly from only a few localities on the Long Range plateau. *Carex stylosa, Cassiope hypnoides, Cornus suecica, Deschampsia atropurpurea, Epilobium hornemannii, Gnaphalium norvegicum, G. supinum, Lycopodium alpinum, Phleum alpinum, Phyllodoce caerulea, Salix herbacea, Sibbaldia procumbens, Stellaria calycantha, Streptopus × oreopolus, Vaccinium cespitosum, V. × nubigenum* and *Viola palustris* are examples of this highly restricted flora.

Alpine Plateau, Peatlands.

PHYSIOGRAPHY AND GEOGRAPHIC DISTRIBUTION. In contrast to the raised bog peatlands of the coastal plain (see previous Peatlands section), the alpine peatland biophysiographic unit consists of comparatively local shallow peat deposits and does not have the characteristic hummocky surface and numerous eccentrically oriented flashets of the lowland bogs.

The peat of this consolidated organic mat seldom exceeds 40 cm. in depth (Airphoto Analysis Associates, 1975). It has generally accumulated on areas of flat or gently sloping alpine terrain where the underlying impermeable bedrock impedes drainage. Such sites occur on gently sloping deposits of shallow glacial drift adjacent to exposed barren bedrock knobs and on flat areas of felsenmeer formation. Exposed erratic boulders frequently protrude through the peat mat. Seepage from adjacent, more elevated barren exposures or from the underlying granitic bedrock is nutrient deficient. In contrast to the highly exposed, often snow-free barrens, the protection afforded by snow cover on these sites may further explain the development of these peat deposits.

This biophysiographic unit generally occurs in conjunction with the tundra barrens and is concentrated in the same northern and southern sectors of the Long Range plateau. In addition, similar peat deposits occur on the alpine plateaus which lie immediately south of Bonne Bay. Thus the flat summit of the Serpentine Tableland, the central plateau area of the Lomond Peninsula, and the highland terraces of Lookout Hills are included in this biophysiographic unit. Although these latter areas differ geologically (see previous Geology section) from the Precambrian Long Range plateau, the peat mantle creates similar physiographic conditions on these sites and the same vegetation type is maintained.

The very poor drainage and the high water table of this biophysiographic unit may lead to the formation of flashets where the peat accumulations are sufficiently deep. These bog pools form in shallow depressions of the peat mat when it is on flat terrain such as in felsenmeer areas. On gradually sloping terrain, a series of descending terraces may be formed in the peat mat with a reticulate pattern of flashets oriented at right angles to the slope. There are several possible explanations for the formation of this flashet pattern. It may be the result of gravitational downslope movement (peat flow) of water saturated organic material (Hanson, 1950). Alternatively, the origin of the flashets may be explained by a differential freeze-thaw cycle of hummocks and hollows in the peat (similar to solifluction movement). Research by Sjörs (1959, 1961, 1963) indicated that such a pattern might be due merely to the formation of fissures as a result of the intrinsic expansion of the peat biomass on an inclined plane. He also emphasized the importance of downslope water flow to maintain this reticulate pattern.

VEGETATION AND FLORA. The vegetation cover of this essentially closed herbaceous community averages 80-100% with intervening exposed boulders and bog pools. It is composed predominantly of *Scirpus cespitosus* and numerous *Carex* species. Unlike the deep, spongy, hummocky *Sphagnum-Cladina* raised bogs of the coastal plain, these sedge peats are relatively shallow and flat. Moss species (*Rhacomitrium lanuginosum* and *Sphagnum* spp.) are an important but not dominant element in the organic mat. Lichen species are virtually absent in contrast to their abundance in the vegetation of both the tundra barrens and the raised bogs.

This alpine sedge vegetation type has been defined as sedge bog or patterned fen (Airphoto Analysis Associates, 1975). Both its species composition and physiognomy tend to be a mixture of the raised bog and the sedge meadow vegetation of the coastal plain. The dominant vascular species of this dwarf herbaceous community are *Scirpus cespitosus* and several common sedges *Carex exilis, C. limosa, C. oligosperma* and *C. pauciflora.* Uncommon but characteristic graminoid species include *Carex bigelowii, C. miliaris, C. stylosa, Calamagrostis pickeringii, Eriophorum spissum, Juncus filiformis* and *Rhynchospora alba.* Although this dwarf vegetation has a tundra-like structure, the flora has virtually none of the arctic-alpine element which characterizes the tundra barrens. Only *Carex bigelowii, C. miliaris* and *C. stylosa* have an arctic-alpine distribution. Non-alpine dwarf heath shrubs and herbs such as *Chamaedaphne calyculata, Drosera rotundifolia, Kalmia polifolia* and *Sanguisorba canadensis* are sparsely scattered throughout this community. Flashets harbour an aquatic flora which is similar to, but less diverse than, the flora of the coastal plain bog pools. Species such as *Carex limosa, C. rostrata, Isoëtes muricata, Nuphar variegata, Sparganium angustifolium* and *S. hyperboreum* are rare to uncommon in these sterile alpine pools.

Immediately south of Bonne Bay, on the plateau areas of Lookout Hills and Lomond Peninsula, the flora of this alpine peatland contains several rare vascular plants. Species such as *Bartonia paniculata, Habenaria blephariglottis, Potamogeton oakesianus* and *Schizaea pusilla* have been recorded from this one boggy alpine habitat within the study area and these plants are at or near the extreme northern range of their eastern American distribution. Other rare species which appear to be restricted mainly to these sedge bogs at Bonne Bay include *Lycopodium inundatum, Potamogeton confervoides* and *Scheuchzeria palustris.*

Toward the central region of the highland Precambrian plateau, where fir forest and scrub vegetation become more predominant, this peatland formation is frequently invaded by isolated clumps of *Abies balsamea* and/or *Picea mariana*. In addition to these tree species, several shrubs such as *Andromeda glaucophylla*, *Chamaedaphne calyculata*, *Kalmia polifolia*, *Ledum groenlandicum*, *Myrica gale*, *Nemopanthus mucronatus* and *Rhododendron canadense* frequently dominate these dense, isolated thickets. This "savanna" type of vegetation could be interpreted as a transition stage between the open dwarf herbaceous vegetation which is typical of this biophysiographic unit and the more protected forested sites (see next section).

Alpine Plateau, Forested Valleys, Ravines, and Talus.

PHYSIOGRAPHY AND GEOGRAPHIC DISTRIBUTION. Sites on the highland plateau, which are suitable for the development of forest or scrub vegetation, are typical of this general biophysiographic unit (Figure 6 B). In comparison with the tundra barrens and open peatlands, local environmental factors which distinguish these forested sites are adequate protection from wind and frost exposure, sufficient soil accumulation and improved drainage. Several landforms meet these physiographic requirements. The glacier-carved valleys and adjacent talus slopes, which constitute much of the rolling topography of the alpine plateau region, are usually densely forested. Here there is less impedance to drainage by underlying bedrock due to the deep colluvial deposits. Smaller ravines or depressions in the barrens create a sheltered habitat with adequate soil deposits for frequent colonization of scrub vegetation (or tuckamoor). Similar upland tuckamoor is frequent on alpine talus where the unstable colluvial slopes and exposure to the pruning action of high winds maintain the vegetation in a scrub stage.

Although these landforms are found scattered throughout the highland plateau, forested slopes become progressively more common toward the central interior region which is bounded on the south by the headwaters of the Upper Humber River system, to the north by the headwaters of Soufflets River, and to the interior by the eastern boundary of St. Barbe South District. Outside this extensive area of concentration, sloping terrain with forest or tuckamoor vegetation occurs at high altitude along the western escarpment of the Long Range. This biophysiographic unit also includes the U-shaped fjord valleys which emerge at high altitude onto the alpine plateau. Similarly, the forested slopes which are found at alpine elevations to the south of Bonne Bay (on the Lomond Peninsula, on Lookout Hills and on the Gregory Plateau), correspond with the botanical and physiographic interpretation of this unit.

VEGETATION AND FLORA. Due to the inaccessibility of the alpine sites occupied by this vegetation type, the following brief description is based on relatively few field observations. It is inferred from the few sites visited that floristically, these forest and scrub communities do not vary appreciably. In fact, the vegetation of this biophysiographic unit is essentially a repetition of the corresponding forest communities of the coastal lowland.

As is the case of the coastal plain, the composition of the forest and scrub communities in the alpine region is very constant despite the variability in colonized landform. Structurally, the major vegetation formations can be described as a function of natural disturbance levels: (a) closed-crown mature forests of *Abies balsamea* which occur mainly on the stable slopes of alpine valleys either at the heads of the fjords or in the central interior region of the Precambrian plateau; (b) wind-shaped upland tuckamoor or scrub which colonizes the unstable and highly exposed talus slopes such as occur along the western escarpment of the Long Range and occasional exposed, well drained moraines and smaller depressions or ravines on the highland plateau; and (c) deciduous shrub thickets generally colonizing the disturbed talus at the base of alpine cliffs and bluffs. This scrub is maintained by falling rock and ice, as well as colluvial ground and snow movement.

Closed-crown Balsam Fir Forests. Most of these alpine forests occur in inaccessible areas of the interior and are consequently mature, undisturbed stands. Like the previously described second growth forests of the coastal plain (see previous Forested Moraines section), the alpine stands are dominated by *Abies balsamea*. *Betula papyrifera*, *Picea glauca* and *P. mariana* are often scattered as associated tree species.

With few exceptions, the shrub and herb strata are of the same composition as their coastal plain counterparts. They are dominated in the same manner by strong regeneration from the canopy trees and similar understory species such as *Acer spicatum*, *Alnus* *crispa, Clintonia borealis, Dryopteris spinulosa,* etc. The ericaceous shrubs, *Rhododendron canadense* and *Vaccinium ovalifolium* are much more common at these higher elevations and may be locally dominant.

Where these forest communities are adjacent to the open slopes of the alpine peatland biophysiographic unit, invasion of the peat slopes by isolated thickets of forest species creates a "savanna" type of vegetation.

Upland Tuckamoor. This wind-shaped alpine scrub resembles very closely the wind-shaped component of the lowland balsam fir forests (i.e. coastal krummholz, see previous Forested Moraines section). These dense stunted thickets are similarly dominated by *Abies balsamea. Picea glauca* which occurs frequently in the krummholz is generally replaced by *Picea mariana* on these alpine slopes. The latter species is absent from the coastal formation, but may locally dominate the tuckamoor. One atypical stand was observed where *Picea glauca* was dominant. *Betula papyrifera* occurs frequently.

The tuckamoor includes additional shrub species of *Amelanchier bartramiana, Empetrum nigrum, Gaultheria hispidula, Kalmia angustifolia, Ledum groenlandicum, Nemopanthus mucronatus, Rhododendron canadense, Taxus canadensis, Vaccinium angustifolium, V. uliginosum* and *V. vitis-idaea* which are virtually absent from the lowland krummholz. The sparse ground flora is made up of the recurring forest herbs *Clintonia borealis, Cornus canadensis, Dryopteris spinulosa, Maianthemum canadense,* etc.

The tuckamoor may grade into a very dense, homogeneous, dwarf black spruce mat which colonizes severely wind-eroded talus slopes. Stunted, prostrate *Picea mariana* invariably dominates this depressed dwarf community. The underlying herb layer is drastically reduced, but the overall floristic composition remains the same as in the *Abies balsamea* dominated tuckamoor.

Deciduous Shrub Thicket (on disturbed talus). This disturbed heterogenous scrub is generally dominated by deciduous shrubs (or small trees) such as *Alnus crispa* and *Betula papyrifera.* Nevertheless, *Abies balsamea* is abundant and locally dominant especially in more stabilized zones. Continual disturbance on the boulder talus maintains an open-structured community and tree stems are usually bent or prostrate due to colluvial ground movement and downslope snow-creep.

The flora is closely related to that of the forest and tuckamoor communities and includes frequent shrubs such as *Acer spicatum, Amelanchier bartramiana, Pyrus decora, Ribes glandulosum, Vaccinium uliginosum* and *Viburnum trilobum.* Small colonies of *Vaccinium cespitosum* form on these disturbed alpine screes and appear to be mainly restricted to this habitat in the study area. Herb coverage among the often exposed boulders on these talus consists largely of pteridophytes such as *Dryopteris spinulosa, D. phegopteris, Osmunda cinnamomea, O. claytoniana* and common recurring species of the *Abies balsamea*-dominated forest and scrub communities.

Alpine Plateau, Serpentine Tableland.

PHYSIOGRAPHY AND GEOGRAPHIC DISTRIBUTION. Table Mountain (Figures 6 C & 6 D) is one of the outstanding physiographic features of the alpine land region of St. Barbe South District. This serpentine massif occupies an area roughly circumscribed by the South Arm of Bonne Bay, the road to Trout River village, and Trout River Pond.

Geologically, this plateau is very distinct from the granitic Precambrian Long Range which predominates the alpine region of the study area. The peculiar geology of this serpentine formation is largely responsible for its unique physiographic and botanical nature. The geomorphology (laterally displaced klippen) of this unit is summarized previously in section Geology.

The principal landforms comprising this biophysiographic unit include the frost-shattered felsenmeer accumulation on the broad summit, till-mantled slopes, actively eroding escarpments, talus slopes, and alluvial scree fans receding from the base of the cliffs.

The serpentine plateau has the appearance of a rock wasteland, colonized by only scanty vegetation cover. Similar barren serpentine outcrops occur in widely scattered areas of Quebec (Scoggan, 1950; Raymond, 1950; Legault et Blais, 1968, map for eastern North America; Hamel, 1970), and elsewhere in Newfoundland (Fernald, 1911, 1933). The remarkable vegetation of these serpentine barrens owes its poverty and uniqueness to the influence of several environmental factors. Rune (1953) and Whittaker *et al.* (1954) concluded that the infertility of serpentine soils for most plants can mainly be attributed to the unfavorable balance of several important elements. Low levels of calcium appear to be most influential.

High concentrations of chromium, nickel and magnesium may possibly attain levels which are toxic to most plants, but which stimulate or at least are tolerated by serpentinicolous plants. Low nutrient levels (particularly of calcium) and the high alkalinity of these ultrabasic rocks are also restrictive factors. There are also exacting physical limitations to prospective colonizing plants. The talus slopes, escarpments, and much of the plateau surface are barren, unstable rock exposures. These alpine landforms are exposed to wind erosion and snow abrasion which create arid, arctic-like conditions. Soil accumulation is minimal due to the lack of biological breakdown processes. The proximity to the surface of the underlying parent bedrock and the absence of insulating vegetation cover, result in mechanical frost-churning or congeliturbation of the surface material.

VEGETATION AND FLORA. Distinctive characteristics generally common to serpentine floras (attenuation, presence of unique edaphic ecotypes, endemism and relic species, disjunctive distributions, etc.) throughout the world have been discussed in detail by Rune (1953) and Whittaker *et al.* (1954).

The physiognomic response of the vegetation to this physiographic unit permits three distinct units to be described: (1) the barrens, comprised of various landforms practically destitute of vegetation such as scree slopes, vertical escarpments, and felsenmeer on the plateau summit; (2) the peat bog covering much of the interior of the flat summit; (3) scrub vegetation at the base of some talus slopes. These categories are most easily interpreted as an opening, lowering, and reduction of the community with less favourable environment (Whittaker *et al.*, 1954).

Serpentine Barrens. Vegetation on the precipitous, rotting cliff faces is virtually absent. The surface of other barren landforms is usually greater than 80% exposed bedrock, interspersed with solitary, wind-pruned shrubs and tufts of grass or other herbs. What scanty vegetation is able to colonize the rock barrens, is restricted to small patches of mineral soil between boulders or along streams.

The sparse vegetation cover consists largely of tolerant shrubby species of wide ecological amplitude. *Juniperus communis* and *Larix laricina* are the most common examples. Other stunted or creeping shrub species which are sporadic on the barren landscape include *Alnus crispa, Betula pumila, Juniperus horizontalis, My-*

rica gale, and *Potentilla fruticosa*. *Rhododendron lapponicum* is found exclusively on the serpentine barrens within the study area. Species such as *Arctostaphylos uva-ursi*, *Salix arctica* and *S. glauca* are also equally characteristic of open calcareous barrens.

The moss, *Rhacomitrium lanuginosum*, and a wide diversity of herbaceous vascular plants sparsely colonize the open barrens. They are mostly restricted to moist patches of weathered gravels which commonly occur along drainage channels or in seepage areas. A characteristic group of plants with an affinity for these open, unstable, serpentine soils — hence, serpentinicolous plants (Rune, 1953) — is known exclusively from this biophysiographic unit within the study area. They include *Adiantum pedatum* var. *aleuticum*, *Arenaria marescens*, *Lychnis alpina* and the previously mentioned shrub *Rhododendron lapponicum*. In addition, a closely related group of plants is found growing preferentially on the serpentine gravels, and may occasionally colonize the similarly open, alkaline barrens of the calcareous coastal plain exposures. This list includes *Anemone parviflora*, *Arenaria humifusa*, *A. rubella*, *Armeria maritima*, *Artemisia borealis*, *A. canadensis*, *Cerastium arvense*, *Danthonia intermedia*, *D. spicata*, *Deschampsia cespitosa*, *Festuca scabrella*, *Oryzopsis asperifolia*, *O. canadensis*, *Oxytropis terrae-novae*, *Saxifraga aizoides*, *S. oppositifolia*, *Senecio pauperculus*, *Solidago hispida*, and *S. multiradiata*. Local areas of calcareous seepage may account for the presence of some of these species which might otherwise be excluded from the serpentine biophysiographic unit. Minor surface deposits of precipitated calcium carbonate or travertine (Airphoto Analysis Associates, 1975) occur at several sites in the serpentine barrens. Restricted colonies of truly calciphilous species such as *Cypripedium calceolus* and *Dryas integrifolia* owe their presence to these calcareous inclusions.

Several species of the coastal plain peatlands recur inconspicuously on wet, sterile gravels of the serpentine barrens. These include *Carex exilis*, *Drosera rotundifolia*, *Sanguisorba canadensis*, *Sarracenia purpurea*, *Selaginella selaginoides*, *Thalictrum pubescens* and *Triglochin maritimum*.

Arctic-alpine plants, found both on coastal plain limestone barrens and on granitic alpine barrens throughout the study area, are also sparsely distributed in this biophysiographic unit. *Carex scirpoidea*, *Juncus trifidus*, *Lycopodium selago*, and *Silene acaulis* are examples.

The flora includes a few species of wider ecological amplitude such as *Campanula rotundifolia, Conioselinum chinense, Potentilla tridentata, Primula mistassinica,* and *Thalictrum alpinum.* Opportunistic species such as *Anaphalis margaritacea* and *Festuca rubra* sporadically invade this open, sterile habitat.

Peat Bog. The interior area of the flat summit of the tableland is partially covered with peat deposits. The somewhat paradoxical peat bog on an otherwise barren plateau which is toxic to most vegetation, is probably due to the particular physiography of the site. The flat, stable terrain, poor drainage, and decreased exposure of the interior plateau area have permitted a gradual accumulation of residual organic debris. This peatland is both botanically and physiographically similar to the peatlands occurring elsewhere in the alpine region of the study area (see Alpine Plateau, Peatlands section). The vegetation on these organic deposits is apparently not influenced by the underlying serpentine bedrock.

Scrub. The barrens grade into a transition zone of more dense scrub vegetation on some of the lower, more stabilized, and less exposed slopes; especially where these talus abut on adjacent geological formations. These scrub communities are dominated by *Larix laricina.* Co-dominant species include *Abies balsamea, Betula papyrifera,* and *Picea mariana.*

The dense undergrowth consists of the same shrub species which colonize the open barrens (*Juniperus communis, J. horizontalis, Myrica gale, Potentilla fruticosa,* etc.), common additional deciduous shrubs (*Acer rubrum, Alnus crispa, A. rugosa, Nemopanthus mucronatus, Viburnum cassinoides, Pyrus decora,* etc.), and common heath shrubs (*Andromeda glaucophylla, Empetrum nigrum, Epigaea repens, Gaultheria hispidula, Kalmia angustifolia, Kalmia polifolia, Ledum groenlandicum, Rhododendron canadense, Vaccinium angustifolium, V. oxycoccos, V. uliginosum, V. vitis-idaea,* etc.). Very stunted *Pinus strobus* (forma *prostrata* of Fernald, 1933) is occasional. Despite the underlying serpentine bedrock, the flora of this scrub community is similar to the upland tuckamoor found on talus slopes elsewhere in the alpine land region (see previous Forested Valleys section). There are, nevertheless, important differences such as the dominance of *Larix laricina,* and the presence of several species which are at or near the northern limit of their distribution such as *Acer rubrum, Epigaea repens,* and *Pinus strobus.* In addition to the anticipated, sparse ground flora of the tuckamoor communities (*Cornus canadensis, Clintonia borealis, Maianthemum canadense,* etc.), exceptional herbaceous species of the open serpentine such as *Oryzopsis asperifolia, Senecio pauperculus* and *Solidago hispida* are found within this dense scrub.

CONCLUSIONS

The complex interplay of environmental, historic and biotic factors has caused a remarkable diversity in the flora of St. Barbe South District in a region where boreal forest is the predominant vegetation type. This flora integrates about 780 vascular plant species from ten distinct phytogeographic groups in the North American flora: Cosmopolitan Element, Circumpolar Element-Northern Hemisphere, Amphiatlantic Element, North American Element-Transcontinental at Canadian Latitudes, North American Element-Discontinuous in Continental Interior, Endemic Element in Northeastern North America, Eastern Deciduous Forest Element, Atlantic Coastal Plain Element, Endemic Element-Gulf of St. Lawrence, and Naturalized Element. This highly diverse flora sorts itself out in the study area in terms of ten major biophysiographic units. Within the lowlying coastal plain occur: Sand Dunes, Tidal Flats and Brackish Shores, Calcareous Exposures, Peatlands, Freshwater Areas, and Forested Moraines, Ridges and Foothills. The alpine region includes: Tundra Barrens, Peatlands, Forested Valleys, Ravines and Talus Slopes, and Serpentine Tableland.

This approach is based on the interaction of factors controlling, on the one hand, the continental "macrodistribution" of species, and on the other, their local "microdistribution" associated with the diverse units making up the biophysiography of the study area. Although the latter categories are particular to the study area, the use of this concept as a tool for describing patterns in vegetation and flora could be successfully applied elsewhere.

The interpretation of the overall geographic distribution or range limits of vascular plants necessitates comprehensive regional floristic studies such as that of the flora of St. Barbe South. The perception of the distribution pattern of a species, or of factors controlling this distribution, is dependent on the continual input of additional information from such intensive local research.

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CANADA

APPENDIX I

ALPHABETICAL LIST OF THE VASCULAR FLORA

Abies balsamea (Linnaeus) Miller
Acer rubrum Linnaeus
Acer spicatum Lamarck
Achillea borealis Bongard
Achillea millefolium Linnaeus
Achillea ptarmica Linnaeus
Aconitum bicolor Schultes
Actaea rubra (Aiton) Willdenow
Adiantum pedatum Linnaeus
Agrimonia striata Michaux
Agropyron repens (Linnaeus) Beauvois
Agropyron trachycaulum (Link) Malte
Agrostis alba Linnaeus
Agrostis borealis Hartman
Agrostis geminata Trinius
Agrostis scabra Willdenow
Agrostis tenuis Sibthorp
Alchemilla filicaulis Buser
Alchemilla minor Hudson
Allium schoenoprasum Linnaeus
Alnus crispa (Aiton) Pursh
Alnus rugosa (DuRoi) Sprengel
Alopecurus aequalis Sobolowski
Alopecurus pratensis Linnaeus
Amelanchier bartramiana (Tausch) Roemer
Amelanchier fernaldii Wiegand
Amelanchier laevis Wiegand
Amelanchier spicata (Lamarck) K. Koch
Ammophila breviligulata Fernald
Anaphalis margaritacea (Linnaeus) Bentham & Hooker
Andromeda glaucophylla Link
Androsace septentrionalis Linnaeus
Anemone canadensis Linnaeus
Anemone multifida Poiret
Anemone parviflora Michaux
Angelica atropurpurea Linnaeus

Angelica laurentiana Fernald
Antennaria albicans Fernald
Antennaria bayardii Fernald
Antennaria brunnescens Fernald
Antennaria cana (Fernald & Wiegand) Fernald
Antennaria columnaris Fernald
Antennaria confusa Fernald
Antennaria eucosma Fernald & Wiegand
Antennaria foggii Fernald
Antennaria gaspensis Fernald
Antennaria neodioica Greene
Antennaria rupicola Fernald
Antennaria spathulata Fernald
Antennaria straminea Fernald
Antennaria vexillifera Fernald
Antennaria wiegandii Fernald
Anthoxanthum odoratum Linnaeus
Arabis alpina Linnaeus
Arabis drummondii A. Gray
Aralia nudicaulis Linnaeus
Arceuthobium pusillum Peck
Arctostaphylos alpina (Linnaeus) Sprengel
Arctostaphylos uva-ursi (Linnaeus) Sprengel
Arenaria dawsonensis Britton
Arenaria humifusa Wahlenberg
Arenaria lateriflora Linnaeus
Arenaria marcescens Fernald
Arenaria peploides Linnaeus
Arenaria rubella (Wahlenberg) J. Smith
Arethusa bulbosa Linnaeus
Armeria maritima (Miller) Willdenow
Arnica chionopappa Fernald
Arnica louiseana Farr
Arnica terrae-novae Fernald
Arnica tomentosa J. M. Macoun
Aronia melanocarpa (Michaux) Elliott
Artemisia borealis Pallas
Artemisia canadensis Michaux
Asplenium viride Hudson
Aster adscendens Lindley

Aster foliaceus Lindley
Aster nemoralis Aiton
Aster novi-belgii Linnaeus
Aster puniceus Linnaeus
Aster radula Aiton
Aster umbellatus Miller
Astragalus alpinus Linnaeus
Astragalus eucosmus Robinson
Athyrium alpestre (Hoppe) Rylands
Athyrium filix-femina (Linnaeus) Roth
Atriplex glabriuscula Edmondston
Atriplex patula Linnaeus
Avena fatua Linnaeus
Avena sativa Linnaeus

Barbarea vulgaris R. Brown
Bartonia paniculata Michaux
Bellis perennis Linnaeus
Betula alleghaniensis Britton
Betula borealis Spach
Betula glandulosa Michaux
Betula michauxii Spach
Betula minor (Tuckerman) Fernald
Betula papyrifera Marshall
Betula pumila Linnaeus
Botrychium lunaria (Linnaeus) Swartz
Botrychium matricariifolium A. Braun
Botrychium multifidum (Gmelin) Ruprecht
Botrychium virginianum (Linnaeus) Swartz
Brachyelytrum erectum (Schreber) Beauvois
Braya purpurescens (R. Brown) Bunge
Bromus ciliatus Linnaeus

Cakile edentula (Bigelow) Hooker
Calamagrostis canadensis (Michaux) Nuttall
Calamagrostis inexpansa A. Gray
Calamagrostis neglecta (Ehrhart) Gaertner, Meyer & Scherbius
Calamagrostis pickeringii A. Gray
Callitriche anceps Fernald
Callitriche hermaphroditica Linnaeus

Callitriche verna Linnaeus
Calopogon tuberosus (Linnaeus) Britton, Sterns & Poggenburg
Caltha palustris Linnaeus
Calypso bulbosa (Linnaeus) Oakes
Campanula rotundifolia Linnaeus
Capsella bursa-pastoris (Linnaeus) Medikus
Cardamine pensylvanica Muhlenberg
Carex angustior Mackenzie
Carex aquatilis Wahlenberg
Carex arctata Boott
Carex atratiformis Britton
Carex aurea Nuttall
Carex bebbii Olney
Carex bicolor Bellardi
Carex bigelowii Torrey
Carex bipartita Bellardi
Carex brunnescens (Persoon) Poiret
Carex buxbaumii Wahlenberg
Carex canescens Linnaeus
Carex capillaris Linnaeus
Carex castanea Wahlenberg
Carex cephalantha (Bailey) Bicknell
Carex chordorrhiza Ehrhart
Carex concinna R. Brown
Carex crawei Dewey
Carex crawfordii Fernald
Carex debilis Michaux
Carex deflexa Hornemann
Carex demissa Hornemann
Carex deweyana Schweinitz
Carex diandra Schrank
Carex disperma Dewey
Carex eburnea Boott
Carex exilis Dewey
Carex flava Linnaeus
Carex glacialis Mackenzie
Carex gracillima Schweinitz
Carex gynocrates Wormskjold
Carex hormathodes Fernald
Carex hostiana DeCandolle

Carex interior Bailey
Carex intumescens Rudge
Carex langeana Fernald
Carex lasiocarpa Ehrhart
Carex lenticularis Michaux
Carex lepidocarpa Tausch
Carex leporina Linnaeus
Carex leptalea Wahlenberg
Carex leptonervia (Fernald) Fernald
Carex limosa Linnaeus
Carex limosa × *C. rariflora*
Carex livida (Wahlenberg) Willdenow
Carex mackenziei Kreczetowicz
Carex maritima Gunnerus
Carex × *mendica* Lepage
Carex michauxiana Boeckeler
Carex microglochin Wahlenberg
Carex miliaris Michaux
Carex misandroides Fernald
Carex muricata Linnaeus
Carex nigra (Linnaeus) Reichard
Carex oligosperma Michaux
Carex paleacea Wahlenberg
Carex pallescens Linnaeus
Carex pauciflora Lightfoot
Carex paupercula Michaux
Carex pedunculata Muhlenberg
Carex × *pieperiana* P. Junge
Carex projecta Mackenzie
Carex rariflora (Wahlenberg) J. E. Smith
Carex rostrata Stokes
Carex rupestris Bellardi
Carex salina Wahlenberg
Carex scirpoidea Michaux
Carex scoparia Schkuhr
Carex serotina Mérat
Carex sterilis Willdenow
Carex stipata Muhlenberg
Carex stylosa C. A. Meyer
Carex × *subviridula* (Kukenthal) Fernald

Carex tenuiflora Wahlenberg
Carex trisperma Dewey
Carex vaginata Tausch
Carex vesicaria Linnaeus
Carex viridula Michaux
Carex viridula × *C. lepidocarpa*
Carex wiegandii Schkuhr
Carex × *Xanthina* Fernald
Carum carvi Linnaeus
Cassiope hypnoides (Linnaeus) D. Don
Castilleja septentrionalis Lindley
Catabrosa aquatica (Linnaeus) Beauvois
Centaurea nigra Linnaeus
Cerastium arvense Linnaeus
Cerastium beeringianum Chamisso & Schlechtendahl
Cerastium terrae-novae Fernald & Wiegand
Cerastium vulgatum Linnaeus
Chamaedaphne calyculata (Linnaeus) Moench
Chelone glabra Linnaeus
Chenopodium album Linnaeus
Chrysanthemum leucanthemum Linnaeus
Cichorium intybus Linnaeus
Cinna latifolia (Treviranus) Grisebach
Circaea alpina Linnaeus
Cirsium arvense (Linnaeus) Scopoli
Cirsium muticum Michaux
Cirsium vulgare (Savi) Tenore
Clintonia borealis (Aiton) Rafinesque
Cochlearia cyclocarpa Blake
Cochlearia tridactylites Banks
Comandra richardsiana Fernald
Conioselinum chinense (Linnaeus) Britton, Sterns & Poggenburg
Conioselinum pumilum Rose
Convolvulus sepium Linnaeus
Coptis groenlandica (Oeder) Fernald
Corallorhiza maculata Rafinesque
Corallorhiza trifida Chatelain
Cornus alba Linnaeus
Cornus canadensis Linnaeus
Cornus suecica Linnaeus

Cornus × *unalaschkensis* Ledebour
Corylus cornuta Marshall
Cryptogramma stelleri (S. G. Gmelin) Prantl
Cypripedium acaule Aiton
Cypripedium calceolus Linnaeus
Cyripedium reginae Walter
Cystopteris bulbifera (Linnaeus) Bernhardi
Cystopteris fragilis (Linnaeus) Bernhardi

Dactylis glomerata Linnaeus
Danthonia intermedia Vasey
Danthonia spicata (Linnaeus) Beauvois
Deschampsia atropurpurea (Wahlenberg) Scheele
Deschampsia cespitosa (Linnaeus) Beauvois
Deschampsia flexuosa (Linnaeus) Trinius
Diapensia lapponica Linnaeus
Digitalis purpurea Linnaeus
Draba arabisans Michaux
Draba glabella Pursh
Draba incana Linnaeus
Draba lactea Adams
Draba norvegica Gunnerus
Drosera anglica Hudson
Drosera intermedia Hayne
Drosera linearis Goldie
Drosera × *obovata* Mertens & Koch
Drosera rotundifolia Linnaeus
Dryas integrifolia Vahl
Dryopteris × *boottii* (Tuckerman) Underwood
Dryopteris cristata (Linnaeus) A. Gray
Dryopteris disjuncta (Ledebour) Morton
Dryopteris filix-mas (Linnaeus) Schott
Dryopteris limbosperma (Allioni) Becherer
Dryopteris noveboracensis (Linnaeus) A. Gray
Dryopteris phegopteris (Linnaeus) Christensen
Dryopteris robertiana (Hoffmann) Christensen
Dryopteris spinulosa (O. F. Mueller) Watt
Dryopteris thelypteris (Linnaeus) A. Gray

Eleocharis acicularis (Linnaeus) Roemer & Schultes

Eleocharis elliptica Kunth
Eleocharis halophila (Fernald & Brackett) Fernald & Brackett
Eleocharis nitida Fernald
Eleocharis palustris (Linnaeus) Roemer & Schultes
Eleocharis parvula (Roemer & Schultes) Link
Eleocharis pauciflora (Lightfoot) Link
Eleocharis smallii Britton
Elymus arenarius Linnaeus
Elymus virginicus Linnaeus
Empetrum eamesii Fernald & Wiegand
Empetrum nigrum Linnaeus
Epigaea repens Linnaeus
Epilobium alpinum Linnaeus
Epilobium anagallidifolium Lamarck
Epilobium angustifolium Linnaeus
Epilobium ciliatum Rafinesque
Epilobium davuricum Fischer
Epilobium glandulosum Lehmann
Epilobium hornemanii Reichenbach
Epilobium latifolium Linnaeus
Epilobium nesophilum (Fernald) Fernald
Epilobium palustre Linnaeus
Epilobium scalare Fernald
Equisetum arvense Linnaeus
Equisetum fluviatile Linnaeus
Equisetum palustre Linnaeus
Equisetum pratense Ehrhart
Equisetum scirpoides Michaux
Equisetum sylvaticum Linnaeus
Equisetum variegatum Schleicher
Erigeron hyssopifolius Michaux
Erigeron philadelphicus Linnaeus
Erigeron strigosus Muhlenberg
Eriocaulon aquaticum (Hill) Druce
Eriophorum angustifolium Honckeny
Eriophorum brachyantherum Trautvetter & Meyer
Eriophorum chamissonis C. A. Meyer
Eriophorum gracile W. D. J. Koch
Eriophorum × *Pylaieanum* Raymond
Eriophorum spissum Fernald

Eriophorum tenellum Nuttall
Eriophorum virginicum Linnaeus
Eriophorum viridi-carinatum (Engelmann) Fernald
Erysimum cheiranthoides Linnaeus
Erysimum coarctatum Fernald
Eupatorium maculatum Linnaeus
Euphrasia americana Wettstein
Euphrasia arctica Lange
Euphrasia disjuncta Fernald & Wiegand
Euphrasia randii Robinson
Euphrasia rigidula Jordan
Euphrasia williamsii Robinson

Festuca brachyphylla Schultes
Festuca elatior Linnaeus
Festuca ovina Linnaeus
Festuca prolifera (Piper) Fernald
Festuca rubra Linnaeus
Festuca saximontana Rydberg
Festuca scabrella Torrey
Festuca vivipara (Linnaeus) J. E. Smith
Fragaria virginiana Duchesne
Fraxinus nigra Marshall

Galeopsis tetrahit Linnaeus
Galium asprellum Michaux
Galium kamtschaticum Steller
Galium labradoricum (Wiegand) Wiegand
Galium palustre Linnaeus
Galium trifidum Linnaeus
Galium triflorum Michaux
Gaultheria hispidula (Linnaeus) Bigelow
Gaylussacia baccata (Wangenheim) K. Koch
Gaylussacia dumosa (Andrews) Torrey & A. Gray
Gentiana amarella Linnaeus
Gentiana nesophila Holm
Gentiana propinqua Richardson
Geocaulon lividum (Richardson) Fernald
Geranium pratense Linnaeus
Geranium robertianum Linnaeus

Geum macrophyllum Willdenow
Geum rivale Linnaeus
Glaux maritima Linnaeus
Glechoma hederacea Linnaeus
Glyceria borealis (Nash) Batchelder
Glyceria canadensis (Michaux) Trinius
Glyceria fluitans (Linnaeus) R. Brown
Glyceria grandis S. Watson
Glyceria striata (Lamarck) Hitchcock
Gnaphalium norvegicum Gunnerus
Gnaphalium supinum Linnaeus
Gnaphalium sylvaticum Linnaeus
Gnaphalium uliginosum Linnaeus
Goodyera repens (Linnaeus) R. Brown
Goodyera tesselata Loddiges

Habenaria blephariglottis (Willdenow) Hooker
Habenaria clavellata (Michaux) Sprengel
Habenaria dilatata (Pursh) Hooker
Habenaria hookeri Torrey
Habenaria hyperborea (Linnaeus) R. Brown
Habenaria obtusata (Banks) Richardson
Habenaria orbiculata (Pursh) Torrey
Habenaria psycodes (Linnaeus) Sprengel
Habenaria straminea Fernald
Habenaria viridis (Linnaeus) R. Brown
Halenia deflexa (J. E. Smith) Grisebach
Hedysarum alpinum Linnaeus
Heracleum maximum Bartram
Hieracium aurantiacum Linnaeus
Hieracium florentinum Allioni
Hieracium floribundum Wimmer & Grabowski
Hieracium groenlandicum Arvet-Touvet
Hieracium kalmii Linnaeus
Hierochloe alpina (Swartz) Roemer & Schultes
Hierochloe odorata (Linnaeus) Beauvois
Hippuris vulgaris Linnaeus
Hordeum jubatum Linnaeus
Hordeum vulgare Linnaeus
Hypericum boreale (Britton) Bicknell

Impatiens capensis Meerburgh
Iris hookeri Penny
Iris versicolor Linnaeus
Isoetes muricata Durieu

Juncus albescens (Lange) Fernald
Juncus × *alpiniformis* Fernald
Juncus alpinus Villars
Juncus articulatus Linnaeus
Juncus balticus Willdenow
Juncus brevicaudatus (Engelmann) Fernald
Juncus bufonius Linnaeus
Juncus canadensis J. Gay
Juncus dudleyi Wiegand
Juncus effusus Linnaeus
Juncus filiformis Linnaeus
Juncus gerardii Loiseleur
Juncus × *nodosiformis* Fernald
Juncus nodosus Linnaeus
Juncus pelocarpus E. Meyer
Juncus stygius Linnaeus
Juncus tenuis Willdenow
Juncus trifidus Linnaeus
Juniperus communis Linnaeus
Juniperus horizontalis Moench

Kalmia angustifolia Linnaeus
Kalmia polifolia Wangenheim
Kobresia simpliciuscula (Wahlenberg) Mackenzie

Lactuca biennis (Moench) Fernald
Lamium purpureum Linnaeus
Lappula myosotis Moench
Larix laricina (DuRoi) K. Koch
Lathyrus japonicus Willdenow
Lathyrus palustris Linnaeus
Ledum groenlandicum Oeder
Leontodon autumnalis Linnaeus
Lesquerella purshii (S. Watson) Fernald
Ligusticum scothicum Linnaeus

Linnaea borealis Linnaeus
Linum catharticum Linnaeus
Listera auriculata Wiegand
Listera borealis Morong
Listera convallarioides (Swartz) Torrey
Listera cordata (Linnaeus) R. Brown
Littorella americana Fernald
Lobelia dortmanna Linnaeus
Lobelia kalmii Linnaeus
Loiseleuria procumbens (Linnaeus) Desvaux
Lomatogonium rotatum (Linnaeus) Fries
Lonicera villosa (Michaux) Roemer & Schultes
Luzula multiflora (Retzius) Lejeune
Luzula parviflora (Ehrhart) Desvaux
Luzula spicata (Linnaeus) DeCandolle
Luzula sudetica (Willdenow) DeCandolle
Lychnis alpina Linnaeus
Lycopodium alpinum Linnaeus
Lycopodium annotinum Linnaeus
Lycopodium clavatum Linnaeus
Lycopodium complanatum Linnaeus
Lycopodium inundatum Linnaeus
Lycopodium lucidulum Michaux
Lycopodium obscurum Linnaeus
Lycopodium sabinifolium Willdenow
Lycopodium selago Linnaeus
Lycopus americanus Muhlenberg
Lycopus uniflorus Michaux
Lysimachia terrestris (Linnaeus) Britton, Sterns & Poggenburg
Lythrum salicaria Linnaeus

Maianthemum canadense Desfontaines
Malaxis brachypoda (A. Gray) Fernald
Malaxis unifolia Michaux
Matricaria maritima Linnaeus
Matricaria matricarioides (Lessing) Porter
Matteuccia struthiopteris (Linnaeus) Todaro
Mentha arvensis Linnaeus
Menyanthes trifoliata Linnaeus
Mertensia maritima (Linnaeus) S. F. Gray

Milium effusum Linnaeus
Mimulus moschatus Douglas
Mitella nuda Linnaeus
Moneses uniflora (Linnaeus) A. Gray
Monotropa hypopithys Linnaeus
Monotropa uniflora Linnaeus
Montia lamprosperma Chamisso
Montia rivularis Gmelin
Muhlenbergia glomerata (Willdenow) Trinius
Myosotis laxa Lehmann
Myosotis scorpioides Linnaeus
Myrica gale Linnaeus
Myriophyllum alterniflorum DeCandolle
Myriophyllum exalbescens Fernald
Myriophyllum tenellum Bigelow

Nemopanthus mucronatus (Linnaeus) Baillon
Nuphar variegata Engelmann

Odontites rubra (Baumgarten) Opiz
Oenothera biennis Linnaeus
Oenothera parviflora Linnaeus
Oenothera perennis Linnaeus
Onoclea sensibilis Linnaeus
Orobanche terrae-novae Fernald
Oryzopsis asperifolia Michaux
Oryzopsis canadensis (Poiret) Torrey
Osmorhiza chilensis Hooker & Arnott
Osmorhiza obtusa (Coulter & Rose) Fernald
Osmunda cinnamomea Linnaeus
Osmunda claytoniana Linnaeus
Osmunda regalis Linnaeus
Oxyria digyna (Linnaeus) Hill
Oxytropis johannensis (Fernald) Fernald
Oxytropis terrae-novae Fernald

Parnassia glauca Rafinesque
Parnassia parviflora DeCandolle
Pastinaca sativa Linnaeus
Pedicularis palustris Linnaeus

Phalaris arundinacea Linnaeus
Phleum alpinum Linnaeus
Phleum pratense Linnaeus
Phyllodoce caerulea (Linnaeus) Babington
Picea glauca (Moench) Voss
Picea mariana (Miller) Britton, Sterns & Poggenburg
Pinguicula vulgaris Linnaeus
Pinus strobus Linnaeus
Plantago juncoides Lamarck
Plantago lanceolata Linnaeus
Plantago major Linnaeus
Plantago oliganthos Roemer & Schultes
Poa alpigena (Fries) Lindman fil.
Poa alpina Linnaeus
Poa annua Linnaeus
Poa compressa Linnaeus
Poa eminens Presl
Poa fernaldiana Nannfeldt
Poa glauca Vahl
Poa nemoralis Linnaeus
Poa palustris Linnaeus
Poa pratensis Linnaeus
Poa saltuensis Fernald & Wiegand
Poa subcaerulea J. E. Smith
Poa trivialis Linnaeus
Pogonia ophioglossoides (Linnaeus) Ker-Gawler
Polygonum amphibium Linnaeus
Polygonum aviculare Linnaeus
Polygonum convolvulus Linnaeus
Polygonum cuspidatum Siebold & Zuccarini
Polygonum fowleri Robinson
Polygonum hydropiper Linnaeus
Polygonum persicaria Linnaeus
Polygonum raii Babington
Polygonum viviparum Linnaeus
Polypodium virginianum Linnaeus
Polystichum braunii (Spenner) Fée
Polystichum lonchitis (Linnaeus) Roth
Populus balsamifera Linnaeus
Populus × *gileadensis* Rouleau

Populus tremuloides Linnaeus
Potamogeton alpinus Balbis
Potamogeton amplifolius Tuckerman
Potamogeton confervoides Reichenbach
Potamogeton epihydrus Rafinesque
Potamogeton filiformis Persoon
Potamogeton gramineus Linnaeus
Potamogeton natans Linnaeus
Potamogeton oakesianus Robbins
Potamogeton perfoliatus Linnaeus
Potentilla anserina Linnaeus
Potentilla crantzii (Crantz) G. Beck
Potentilla egedei Wormskjold
Potentilla fruticosa Linnaeus
Potentilla nivea Linnaeus
Potentilla norvegica Linnaeus
Potentilla palustris (Linnaeus) Scopoli
Potentilla pectinata Rafinesque
Potentilla tridentata Aiton
Prenanthes trifoliolata (Cassini) Fernald
Primula egaliksensis Wormskjold
Primula laurentiana Fernald
Primula mistassinica Michaux
Prunella vulgaris Linnaeus
Prunus pensylvanica Linnaeus fil.
Prunus virginiana Linnaeus
Pteridium aquilinum (Linnaeus) Kuhn
Puccinellia coarctata Fernald & Weatherby
Puccinellia paupercula (Holm) Fernald & Weatherby
Pyrola asarifolia Michaux
Pyrola chlorantha Swartz
Pyrola minor Linnaeus
Pyrola rotundifolia Linnaeus
Pyrola secunda Linnaeus
Pyrus americana (Marshall) DeCandolle
Pyrus decora (Sargent) Hyland

Ranunculus abortivus Linnaeus
Ranunculus acris Linnaeus
Ranunculus cymbalaria Pursh

Ranunculus hyperboreus Rottboell
Ranunculus macounii Britton
Ranunculus pensylvanicus Linnaeus fil.
Ranunculus repens Linnaeus
Ranunculus reptans Linnaeus
Ranunculus trichophyllus Chaix
Rhamnus alnifolius L'Héritier
Rhinanthus borealis (Sterneck) Chabert
Rhinanthus crista-galli Linnaeus
Rhododendron canadense (Linnaeus) Torrey
Rhododendron lapponicum (Linnaeus) Wahlenberg
Rhynchospora alba (Linnaeus) Vahl
Rhynchospora capillacea Torrey
Rhynchospora fusca (Linnaeus) Aiton fil.
Ribes glandulosum Grauer
Ribes hirtellum Michaux
Ribes lacustre (Persoon) Poiret
Ribes triste Pallas
Rorippa islandica (Oeder) Borbas
Rosa nitida Willdenow
Rosa virginiana Miller
Rubus acaulis Michaux
Rubus arcticus Linnaeus
Rubus chamaemorus Linnaeus
Rubus idaeus Linnaeus
Rubus pubescens Rafinesque
Rumex acetosa Linnaeus
Rumex acetosella Linnaeus
Rumex crispus Linnaeus
Rumex fenestratus Greene
Rumex longifolius DeCandolle
Rumex mexicanus Meissner
Rumex obtusifolius Linnaeus
Rumex orbiculatus A. Gray
Rumex pallidus Bigelow
Ruppia maritima Linnaeus

Sagina nodosa (Linnaeus) Fenzl
Sagina procumbens Linnaeus
Sagittaria graminea Michaux

Salicornia europaea Linnaeus
Salix arctica Pallas
Salix arctophila Cockerell
Salix bebbiana Sargent
Salix candida Fluegge
Salix cordata Michaux
Salix discolor Muhlenberg
Salix glauca Linnaeus
Salix glaucophylloides Fernald
Salix herbacea Linnaeus
Salix lanata Linnaeus
Salix lucida Muhlenberg
Salix myrtillifolia Andersson
Salix pedunculata Fernald
Salix pellita Andersson
Salix planifolia Pursh
Salix reticulata Linnaeus
Salix rigida Muhlenberg
Salix serissima (L. H. Bailey) Fernald
Salix uva-ursi Pursh
Salix vestita Pursh
Salix wiegandii Fernald
Salsola kali Linnaeus
Sambucus pubens Michaux
Sanguisorba canadensis Linnaeus
Sanicula marilandica Linnaeus
Sarracenia purpurea Linnaeus
Satureja vulgaris (Linnaeus) Fritsch
Saxifraga aizoides Linnaeus
Saxifraga cespitosa Linnaeus
Saxifraga oppositifolia Linnaeus
Saxifraga paniculata Miller
Scheuchzeria palustris Linnaeus
Schizachne purpurascens (Torrey) Swallen
Schizaea pusilla Pursh
Scirpus acutus Muhlenberg
Scirpus americanus Persoon
Scirpus atrocinctus Fernald
Scirpus cespitosus Linnaeus
Scirpus cyperinus (Linnaeus) Kunth

Scirpus hudsonianus (Michaux) Fernald
Scirpus rubrotinctus Fernald
Scirpus rufus (Hudson) Schrader
Scirpus subterminalis Torrey
Scrophularia nodosa Linnaeus
Scutellaria epilobiifolia A. Hamilton
Scutellaria lateriflorus Linnaeus
Secale cereale Linnaeus
Sedum rosea (Linnaeus) Scopoli
Selaginella selaginoides (Linnaeus) Link
Senecio aureus Linnaeus
Senecio gaspensis Greenman
Senecio pauciflorus Pursh
Senecio pauperculus Michaux
Senecio pseudo-arnica Lessing
Senecio vulgaris Linnaeus
Shepherdia canadensis (Linnaeus) Nuttall
Sibbaldia procumbens Linnaeus
Silene acaulis (Linnaeus) Jacquin
Sisyrinchium montanum Greene
Smilacina stellata (Linnaeus) Desfontaines
Smilacina trifolia (Linnaeus) Desfontaines
Solidago × *calcicola* Fernald
Solidago canadensis Linnaeus
Solidago hispida Muhlenberg
Solidago lepida DeCandolle
Solidago macrophylla Pursh
Solidago multiradiata Aiton
Solidago purshii Porter
Solidago rugosa Miller
Solidago sempervirens Linnaeus
Solidago uliginosa Nuttall
Sonchus arvensis Linnaeus
Sonchus oleraceus Linnaeus
Sparganium angustifolium Michaux
Sparganium chlorocarpum Rydberg
Sparganium eurycarpum Engelmann
Sparganium hyperboreum Laestadius
Sparganium minimum (Hartman) Fries
Spartina pectinata Link

Spergularia canadensis (Persoon) Don
Spergularia rubra (Linnaeus) Presl & Presl
Sphenopholis intermedia Rydberg
Spiraea latifolia (Aiton) Borkhausen
Spiranthes romanzoffiana Chamisso
Stachys palustris Linnaeus
Stellaria calycantha (Ledebour) Bongard
Stellaria crassifolia Erhart
Stellaria graminea Linnaeus
Stellaria humifusa Rottboell
Stellaria longipes Goldie
Stellaria media (Linnaeus) Cyrillo
Streptopus amplexifolius (Linnaeus) DeCandolle
Streptopus × *oreopolus* Fernald
Streptopus roseus Michaux

Tanacetum huronense Nuttall
Tanacetum vulgare Linnaeus
Taraxacum ambigens Fernald
Taraxacum ceratophorum (Ledebour) DeCandolle
Taraxacum lapponicum Kihlman
Taraxacum latilobum DeCandolle
Taraxacum officinale Weber
Taxus canadensis Marshall
Thalictrum alpinum Linnaeus
Thalictrum pubescens Pursh
Tofieldia glutinosa (Michaux) Persoon
Tofieldia pusilla (Michaux) Persoon
Trientalis borealis Rafinesque
Trifolium agrarium Linnaeus
Trifolium hybridum Linnaeus
Trifolium pratense Linnaeus
Trifolium repens Linnaeus
Triglochin × *gaspense* Lieth & D. Löve
Triglochin maritimum Linnaeus
Triglochin palustre Linnaeus
Trillium cernuum Linnaeus
Trisetum melicoides (Michaux) Vasey
Trisetum spicatum (Linnaeus) Richter
Triticum aestivum Linnaeus

Tussilago farfara Linnaeus
Typha latifolia Linnaeus

Urtica dioica Linnaeus
Utricularia cornuta Michaux
Utricularia intermedia Hayne
Utricularia minor Linnaeus
Utricularia vulgaris Linnaeus

Vaccinium angustifolium Aiton
Vaccinium cespitosum Michaux
Vaccinium macrocarpon Aiton
Vaccinium × *nubigenum* Fernald
Vaccinium ovalifolium J. E. Smith
Vaccinium oxycoccos Linnaeus
Vaccinium uliginosum Linnaeus
Vaccinium vitis-idaea Linnaeus
Verbascum thapsus Linnaeus
Veronica americana (Rafinesque) Schweinitz
Veronica arvensis Linnaeus
Veronica officinalis Linnaeus
Veronica scutellata Linnaeus
Veronica serpyllifolia Linnaeus
Veronica tenella Allioni
Viburnum cassinoides Linnaeus
Viburnum edule (Michaux) Rafinesque
Viburnum trilobum Marshall
Vicia cracca Linnaeus
Viola adunca J. E. Smith
Viola cucullata Aiton
Viola incognita Brainerd
Viola labradorica Schrank
Viola nephrophylla Greene
Viola pallens (Banks) Brainerd
Viola palustris Linnaeus
Viola renifolia A. Gray
Viola renifolia × *pallens*
Viola selkirkii Pursh
Viola septentrionalis Greene

Woodsia alpina (Bolton) S. F. Gray
Woodsia glabella R. Brown
Woodsia ilvensis (Linnaeus) R. Brown

Zannichellia palustris Linnaeus
Zostera marina Linnaeus